Crack Spread Trading:
The Pekin Duck Strategy

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Fully mature adult Pekin ducks weigh between 8 and 11 pounds in captivity. Their average lifespan (if not eaten at an early age) is about 9 to 12 years. Their external feathers are white, sometimes with a yellowish tinge.
As precocial birds, Pekin ducks make ideal companion animals for a variety of reasons. As a duck imprints on a human, the bond of trust that develops rivals that of humans and dogs. Pekin ducks are very intelligent, and are capable of lifelong strong and loyal bonds with humans, and often then prefer human company over the company of other ducks.
(en.wikipedia.org/wiki/American_Pekin_Duck)

Abstract:

I introduced in a recent working-paper the Wild and Black Duck strategy (see [1]). The Wild and Black Duck trades Natural Gas calendar spreads.
The Pekin Duck trades with crack spreads. The crack can be combined with a calendar spread. The standard crack is -3:2:1. Shorting 3 crude oil futures (CL) and going 2 gasoline (RB) and 1 heating oil (HO) futures long [2]. This spread coincides with the production process. But according a preliminary visual and statistical study this combination is – at its best – very weakly CoIntegrated. This is also true for -1:1:0 (CL v. RB) and -1:0:1 (CL v. HO). There is only one interesting crack left: 0:-1:1 or gasoline (RB) versus heating oil (HO). This is also in agreement with trading experience ([3]).
Trading this spread is termed the Pekin Duck strategy. The Pekin is so far the most attractive within the Duck breeds. Trading only the crack spread is a relative save bet. But there are periods were no interesting pair is available. Combining the crack- with a calendar spread creates more fun and risk.

Contract Specifications and Volume:

Although crude oil (CL), gasoline (RB) and heating oil (HO) are closely related, the contract specifications differ somewhat. Trading for RB and HO ceases on the last last business day of the month preceding the delivery month. Trading for crude oils ends on the third business day prior to the twenty-fifth calendar day of the month preceding the delivery month.
The price of CL is in $ per barrel, for RB and HO the unit is gallons. A future contract is either for 1000 barrels of crude oil or 42.000 gallons of gasoline or heating oil. The unit differs, but the quantity is the same. For this study all prices, trading costs and contract sizes are calculated in the more handy unit of barrels.
The CBOE offers futures for the -1:1:0 (CL v. RB) and -1:0:1 (CL v. HO) spread. The tickers are RM and HK. But these spreads are very illiquid. The volume information notes at of this writing a minor open interest, but there was not a single trade in the first week of December 2013.
CL, RB and HO are in contrast very liquid. CL is liquid up to 2 years, RB and HO for one year. There is a clear preference for the quarterly futures HMUZ (see Table-1).

Month	Crude-Oil	Gasoline	Heating-Oil
JAN 14	223.944	55.230	48.956
FEB 14	95.091	29.878	19.814
MAR 14	50.137	15.773	12.182
APR 14	21.957	7.540	7.522
MAY 14	16.172	5.498	4.397
JUN 14	33.053	2.531	3.984
JUL 14	6.753	726	718
AUG 14	4.502	707	320
SEP 14	7.931	517	307
OCT 14	4.529	196	79
NOV 14	3.208	25	146
DEC 14	29.054	389	1.425
JAN 15	1.286	4	7
FEB 15	819	0	1
MAR 15	1.217	0	1
APR 15	228	0	1
MAY 15	74	0	1
JUN 15	4.047	0	26
JUL 15	285	0	0
AUG 15	9	0	0
SEP 15	90	0	0
OCT 15	0	0	0
NOV 15	0	0	0
DEC 15	5.310	0	0

Table-1: Volume of CL, RB and HO at 2013.12.06

The Pekin Duck:

The Pekin Duck is based on the following equations:

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Z(t) = c0*X(t) + c1*Y(t) (1)

NZ(t) = (Z(t)-m)/std     (2)

dNZ(t) = a + b*NZ(t-1)   (3)
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alternatively

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dNZ(t) = b0*I*NZ(t-1) + b1*(1-I)*NZ(t-1) (3a)
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with

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dNZ(t) = NZ(t)-NZ(t-1)   (4)

Were c0, c1 are the crack weights. For 0:-1:1 c0=-1, c1=1,
NZ(t) is the normalized spread.
m is the mean or the more robust median of Z.
std is the standard-deviation or the robust MAD*1.4826 of Z.
b in (3) is the mean reversion factor.
mean-reversion is modeled asymmetric in (3a).
I is the indicator function for NZ(t-1) > 0.
b0 is the mean-reversion for a positive spread
b1 for a negative spread.
dNZ(t) is the daily change in the normalized spread.
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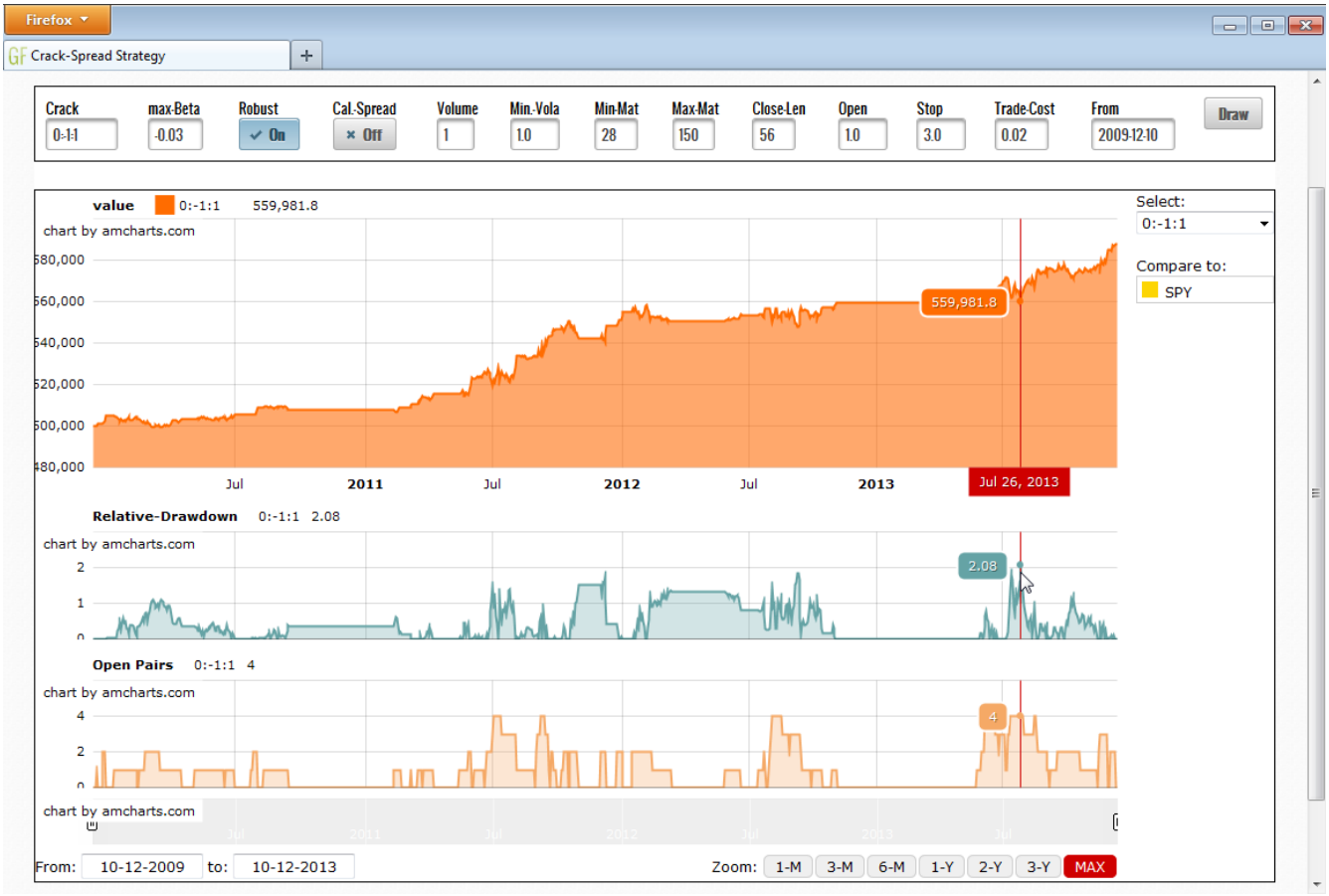
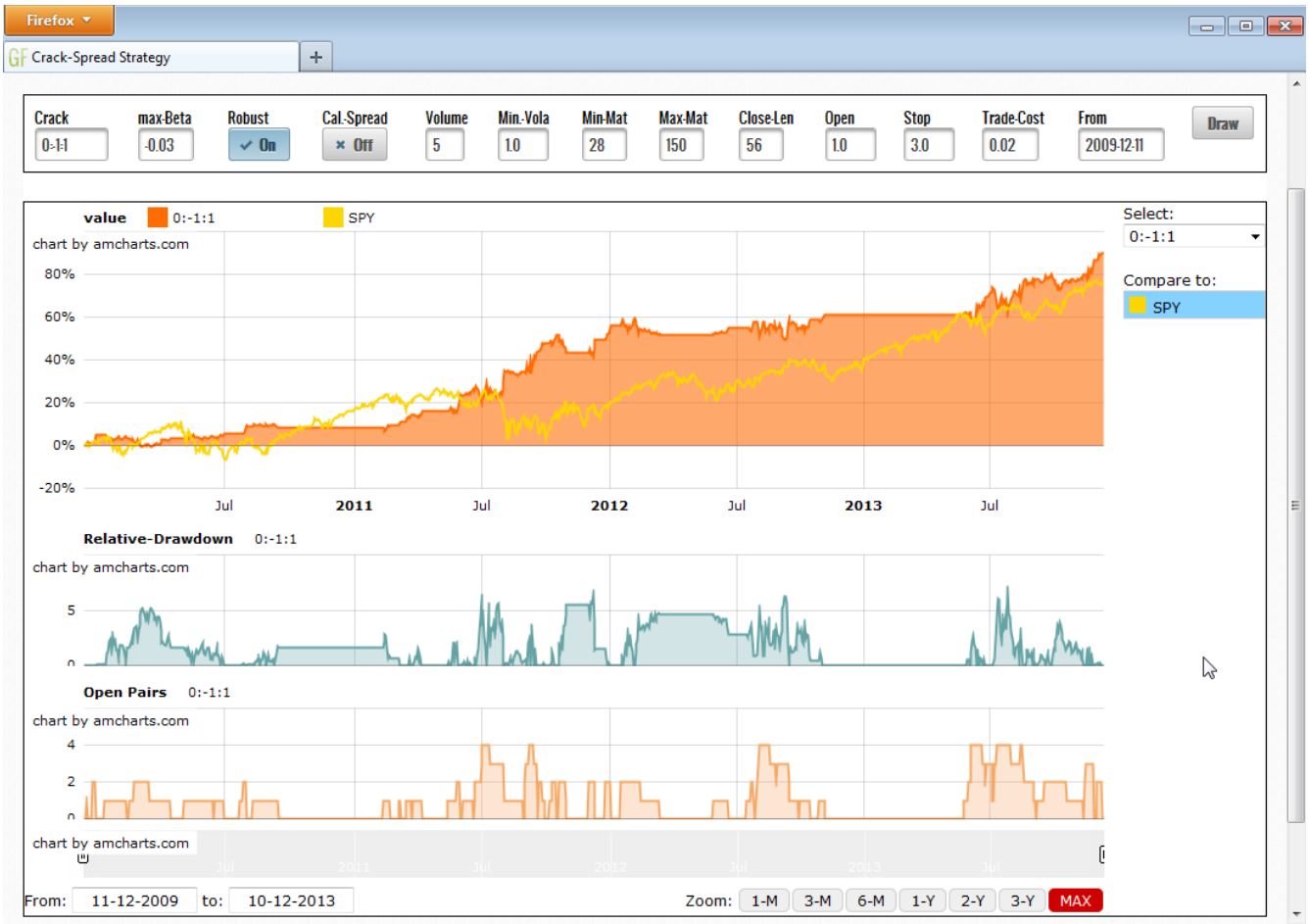
Equation (1) defines the spread. For 0:-1:1 it is simply the price (per barrel) of Heating-Oil minus the price of Gasoline. In the second step one normalizes the spread. One can use either the conventional least-squares measures mean and standard-deviation or the robust median and MAD (Median-Absolute-Deviation). The robust variants give – as in previous studies – better results. This is especially important if one uses the asymmetric equation (3a). With the median there are by definition half of the normalized values positive, half negative. The MAD is scaled with 1.4826. If the distribution is normal, the scaled MAD is identical to the standard-deviation. The tails are usually not too far away from the normal. But the distribution is skewed. The median has a greater effect than the MAD.
Equation (3) calculates the mean-reversion. This assumes the same mean-reversion effect for negative and positive spreads. In [4] the authors propose the asymmetric model of equation (3a). There seems to be a different mechanism for mean-reversion. But in contrast to [4] I have found no universal pattern. Sometimes b0 and sometimes b1 shows a stronger mean-reversion. In any case, the trading results improve if one uses (3a). Equation (3) is calculated with the Theil-Sen regression estimator. The Theil-Sen estimator is robust and almost as efficient as OLS (see [5]). Unfortunately there is no straightforward version for the multilinear regression (3a). Therefore OLS was used.

As in [1] the window-length for calculating the statistics was 126 trading-days. On a given day t one calculates (1) and (2) for all pairs of the next 5 Futures. These futures have according to Table-1 sufficient liquidity. One needs additionally half a year of historic data for the spread calculation. Although volume diminishes, one has nevertheless reasonable trading prices.
The minimum maturity must be – in the best setting – 28 calendar days. Otherwise there is not enough time for mean-reversion. The spread is always closed 14 days before expiry. In [1] this was 7 days. 14 days gave slightly better results, but the difference does not matter too much.



Graphic-1: Crack-Spread from 2009-12-10 to 2013-12-10

Generally the result is quite robust to different settings. One can use also the next 6 maturities. A longer maturity makes no difference, because one has in this case no reliable data for the spread calculation (see Table-1) (if there are less than 120 common trading days, the crack pair is skipped). The position is always closed after 8 weeks. The result is again quite robust to different values.
The standard-deviation (actually MAD*1.4826) of the original spread in (1) must be greater than 1.0. This is again in agreement with the results in [1] and [3]. The mean-reversion factor beta must be below -0.03. If the spread is currently positive, one uses parameter b0 and b1 in the opposite case.
The position is opened, if the normalized spread in (2) is larger/smaller than 1 standard-deviation.
A Stop-Loss is triggered, if the spread increases by additional 3 standard-deviations.
The trading costs are assumed to be 2 Cents per barrel or 20 $ per future. A round trip of 1 spread amounts to 80$ of trading costs. All these settings are the same than in [1]. One could tune the results slightly with different parameters. But I preferred the old values, because this reduces the data snooping effect.
Graphic-1 shows the performance in the last 4 years from 2009-12-10 till 2013-12-10. One starts with an initial value of 500.000$. The final value is 587.737$. This is not very spectacular, but the index is rather smooth. The maximum relative drawdown (blue-middle-chart) is only 2.1%. The bottom chart shows the number of open spreads. There are longer phases with no open position. The maximum number of open spreads is 4 (or 8 futures). The Pekin-Duck beats the SPY over the 4 years, if one increases the volume to 5 futures per spread. There are now up to 40 futures open. The Pekin-Duck gains 89.9%, the SPY 76.8% (see Graphic-2). The max. relative drawdown is with 6.8% only one third of the SPY. The two series behave also quite different. Combining the Duck with the SPY (or other market long strategies) seems to be a good diversification.

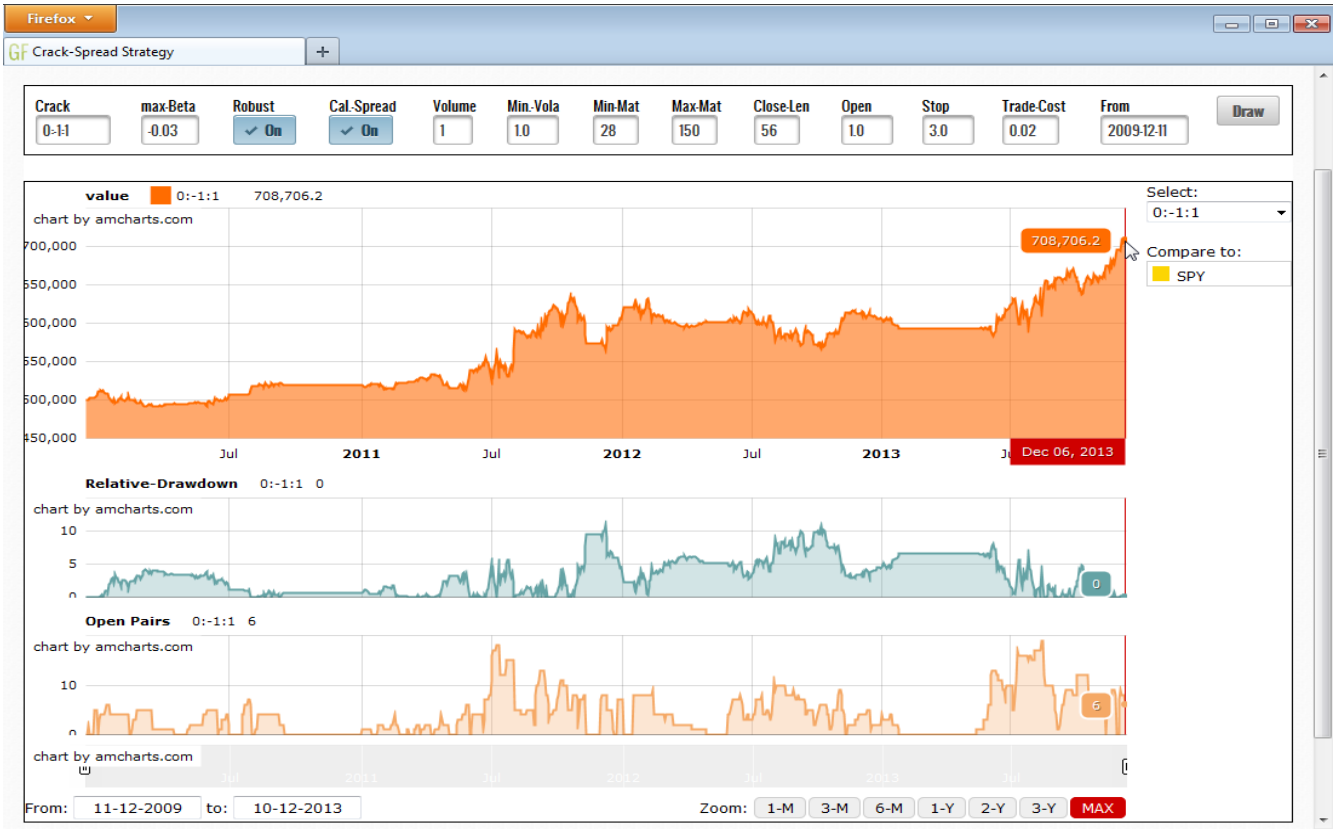


Graphic-2: 5x Crack-Spread (orange) and SPY (yellow) from 2009-12-10 to 2013-12-10

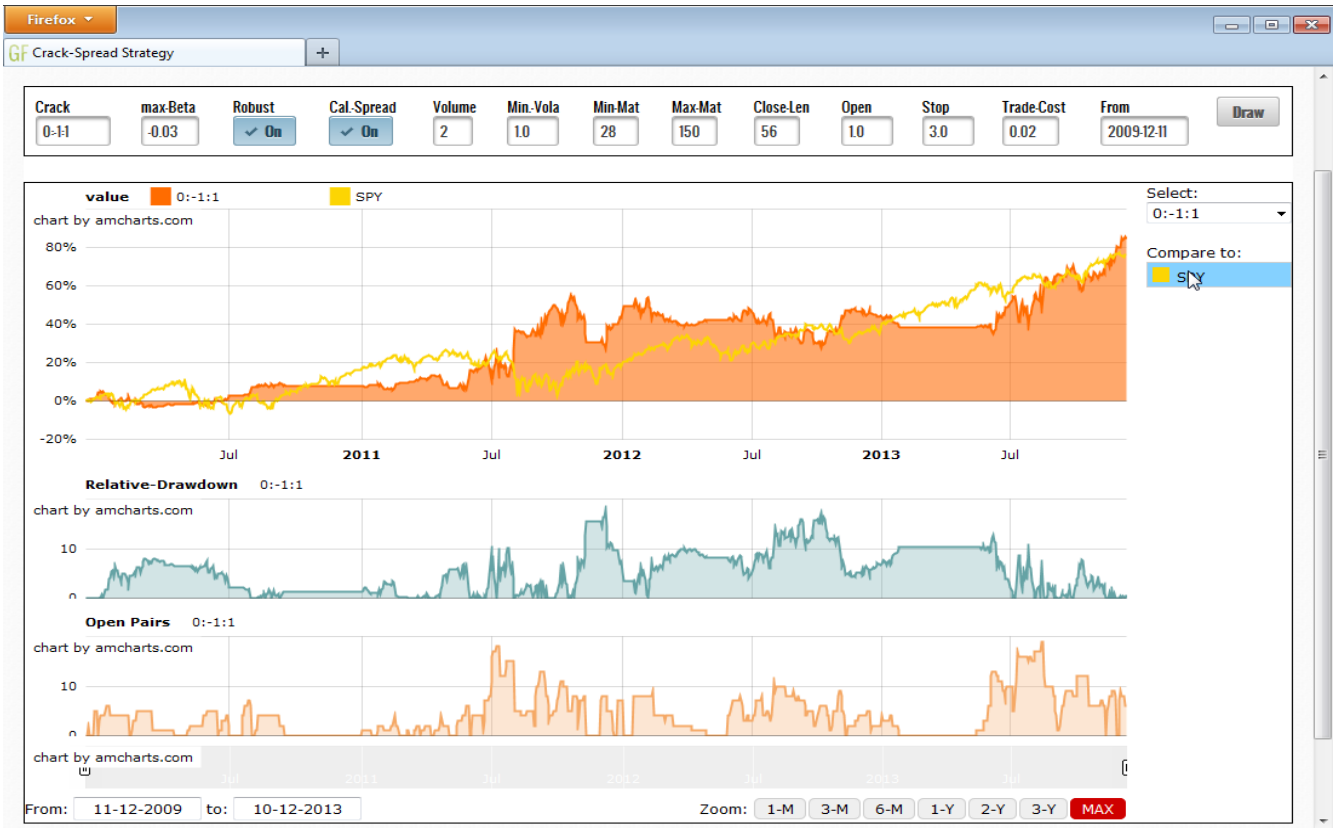
***Shuāngxǐ*?**

Double Happiness (simplified Chinese: 双喜; traditional Chinese: 雙喜; pinyin: shuāngxǐ) is a Chinese ornamental design commonly used as a decoration.
(en.wikipedia.org/wiki/Double_Happiness_(calligraphy))

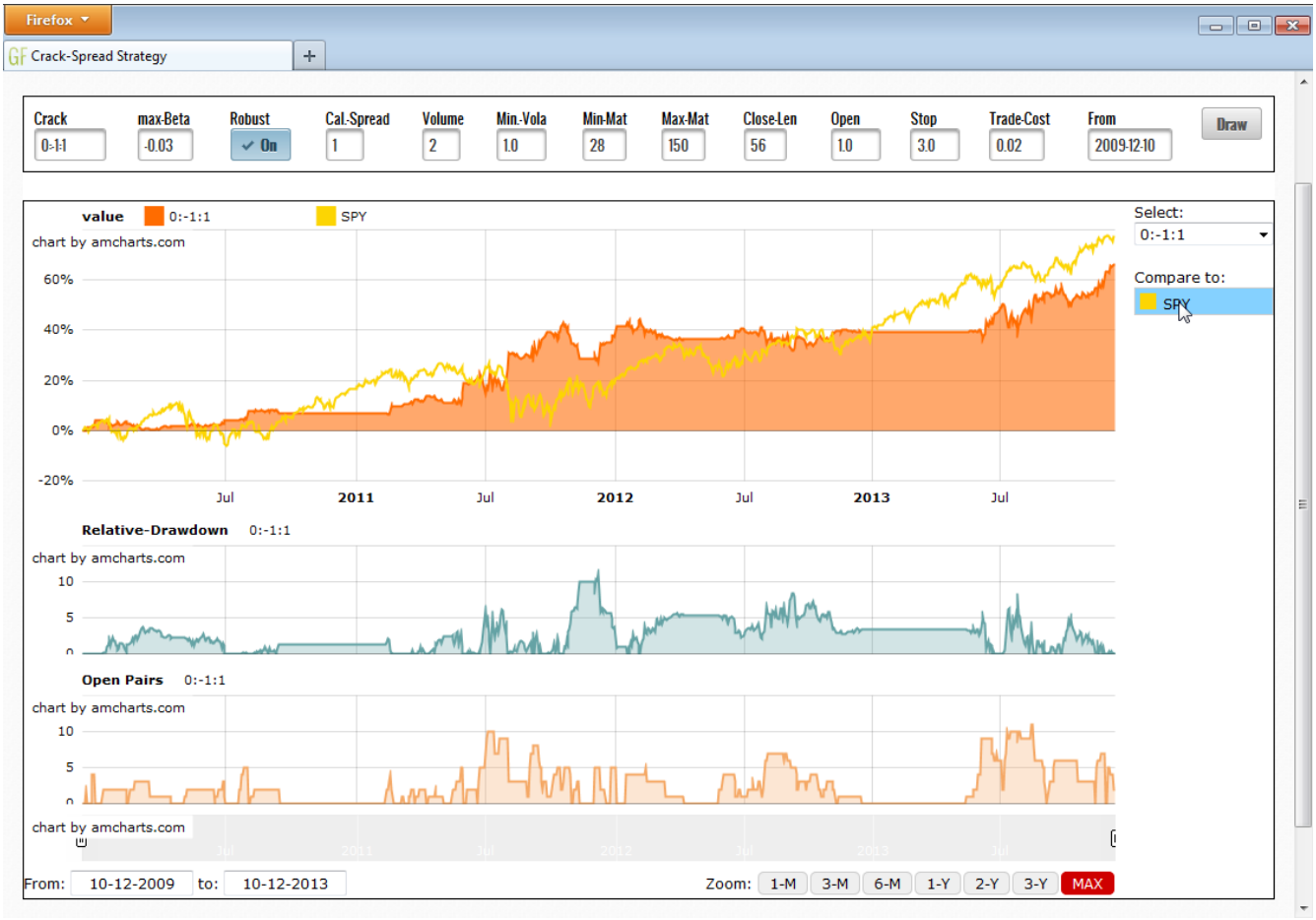
So far both futures have the same maturity. One trades only the crack spread. But one can combine a crack- and calendar spread. Is a double spread also Double Happiness?
The answer is given in Graphic-3. One trades – with the same rules as above – also all possible calendar-spreads between gasoline and heating oil (but there must be always a crack involved).
The trading volume and also the overall profit is considerable increased. The final value is 708.707$ or 41.7%. But there are now up to 14 pairs open and the max. relative drawdown increases to 10.9%. One has to double the volume per trade to beat the SPY. There are up to 56 Futures at the same time open.
The performance increases to 84.5%, the max. relative drawdown is 17.8%. This is about the same size than the drawdown of the SPY.
Graphic-5 shows a compromise. The calendar spread is restricted to one maturity. One can combine RBG14 with HOH14 but not RBH14 with HOM14. The performance reduces from 84.5% to 66.2%. But the risk is also considerable reduced. The max. relative drawdown is for this combination 11.1%. There are up to 44 futures at the same time open.



Graphic-3: Crack-Calendar-Spread from 2009-12-10 to 2013-12-10



Graphic-4: 2x Crack-Calendar-Spread (orange) and SPY (yellow) from 2009-12-10 to 2013-12-10



Graphic-5: 2x Crack-Calendar(1)-Spread (orange) and SPY (yellow) from 2009-12-10 to 2013-12-10

Conclusion:

The Pekin is so far the most attractive within the Duck breeds. Trading only the crack spread is a relative save bet. But there are periods were no interesting pair is available. Combining the crack- with a calendar spread creates more fun and risk. At least in the historic sample it is in the long run better to trade the simple crack with a higher volume instead of entering more frequently the crack-calendar combinations. Generally it is not a disadvantage of a strategy if one stays for some time at the sideline and enters a position only under favorable circumstances.

References:

[1] Donninger Ch.: Natural Gas Pairs Trading without CoIntegration: The Wild and Black Duck Strategy, Sibyl-Working-Paper, Nov. 2013
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[3] Ryan Pat: Personal Communication.
[4] Girma P.: Do Heating-Oil Prices Adjust Asymmetrically to Changes in Crude Oil Prices, Journal of Business & Economics Research – July 2011
[5] Wilcox, R.: Introduction to Robust Estimation, Chap. 10.2 Theil–Sen Estimator, Academic Press, 2005.
[6] Kanamura T., Rachev S., Fabozzi F.: A profit model for spread trading with application to energy futures, KIT-Working-Paper-Series No.27, May 2011.