

InOutBars SAR

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Abstract

In this paper, we introduce InOutBars SAR, a stop and reverse system based on the concept of outbars and following inbars.

The system follows up- and down-movements of an underlying price process with stop and reverse when the direction of the movement is changed. This SAR system is complemented by the intra-period stop process StopInOutBars, which is also based on the idea of outbars and following inbars and thus gives an open position more space to move as long as an outbar is active.

Comprehensive tests show that these stop processes may be applied successfully when the market is in movement. Compared to other standard stops, the performance is competitive and often even better.

1 Introduction

The concept of inbars and outbars is commonly used as trading concept to generate meaningful stops when the price process of an underlying stock is in movement (cf. [6]).

For instance, the candle stick chart of the price process in Figure 1 shows a clear up-movement in the first six bars. Each of these bars closes at a higher level than the whole range of the forerunner bar. In the seventh bar (17 o'clock) the buying power has not enough strength to again close above the range of the sixth bar. Since the body of the seventh bar stays within the range of the sixth bar, we call this bar an *inbar* or more precisely an *initializing inbar*; the forerunner bar is called an *outbar*.

Usually the price process, once an outbar is established, tends to consolidate, i.e. the movement of the price process is stopped for a while and the initializing inbar is followed by a series of further inbars with respect to the earlier established active outbar.

Once a new bar is able to close outside the range of the active outbar, either the up-movement is continued (in case the outbar is broken on the upper side), or a new down-movement is initialized (in case the outbar is broken on the lower side). Of course an up-movement can break down also instantaneously without having established an outbar beforehand. Figure 2 yields an example in terms of the 19 o'clock-bar which closes below the low of the forerunner.

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Figure 1: Outbars and following inbars

This way a direction (up or down) may be associated to each price process. Once the direction process stops, it immediately reverses, i.e. it builds a stop and reverse process (SAR). The outline of this paper is as follows. In Section 2, we give a precise definition of the above mentioned direction process based on in- and outbars. We call this direction indicator InOutBars SAR. In the following section, we describe how this idea may be complemented by a meaningful intra-period stop process (called StopInOutBars) that gives the price process more space to develop when an active outbar and inbars are present. In Section 4, we give statistical observations and a comparison with other standard stops such as Parabolic SAR, PeriodHighLow and TrailStop. Furthermore, confidence intervals and the probability for a positive net profit are calculated. It turns out that InOutBars SAR and StopInOutBars perform very well when the market is in movement. In Section 5, we conclude this paper with a brief summary of the afore made findings.

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2 The Direction Process: InOutBars SAR

We introduce the following parameters to build a diffuse region around an outbar consisting of the range of the outbar plus some tolerance:

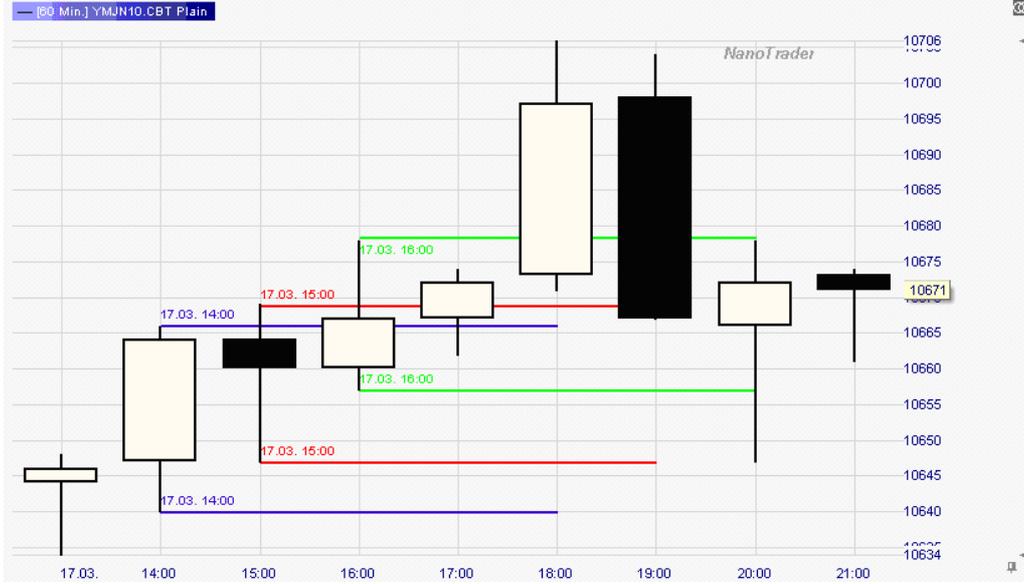


Figure 2: Nested in/outbars and immediate return

- $\$param_outbar_ini$ describes the region at the moment when the outbar is initialized
- $\$param_outbar$ describes the region that contains the bodies of consecutive inbars
- $\$param_close_inside$ describes a larger diffuse region around the outbar that is used, in case the examined bar closes inside the range of the outbar.

All three parameters are supposed to be small integers with

$$0 \leq \$param_outbar_ini \leq \$param_outbar \leq \$param_close_inside. \quad (1)$$

The following two definitions state conditions when an outbar and consecutive inbars are present. All conditions have to be checked at the end of the current period with closing price $Close[0]$.

Definition 2.1 (outbar and inbars)

- (a) *The current period $n = 0$ forms an (initializing) inbar to the forerunner period $n = 1$, if*

$$\max \{ Open[0], Close[0] \} \leq High[1] + \$param_outbar_ini$$

and

$$\min \{ Open[0], Close[0] \} \geq Low[1] - \$param_outbar_ini.$$

*In this case the forerunner period is called an **active outbar**.*

Recursively, we define (**following**) inbars:

(b) If $m \geq 2$ is the number of an active outbar for the inbars $n = m - 1, \dots, 1$, then, in order to check whether the current period $n = 0$ is a **(following) inbar**, we calculate:

$$\begin{aligned}
maxi &:= \max \{ Open[0], Close[0] \} \\
mini &:= \min \{ Open[0], Close[0] \} \\
usualinbar &:= (maxi \leq High[m] + \$param_outbar) \\
&\quad \text{and} \\
&\quad (mini \geq Low[m] - \$param_outbar) \\
goodclose &:= (Close[0] \leq High[m]) \text{ and } (Close[0] \geq Low[m]) \\
broadinbar &:= (maxi \leq High[m] + \$param_close_inside) \\
&\quad \text{and} \\
&\quad (mini \geq Low[m] - \$param_close_inside)
\end{aligned}$$

In case

$$usualinbar \text{ or } (goodclose \text{ and } broadinbar)$$

is true, the period $n = 0$ is a **(following) inbar** for the active outbar m .

Due to (1), the condition for following inbars is relaxed from being an initializing inbar. In particular, when the examined bar closes inside the range of the outbar, the condition for following inbars is further relaxed. As long as an outbar is active, we examine the following periods to find out whether they are inbars of this outbar. Once the current period is no longer a following inbar, the so far active outbar is called **broken**.

Typically, when this happens, there will no longer be an active outbar. However, sometimes one of the inbars of the former outbar becomes a new outbar, as seen in Figure 2.

Definition 2.2 (renewed outbar)

If $m \geq 2$ is the number of an active outbar for the inbars $n = m - 1, \dots, 1$ that is broken at the current period $n = 0$, we check for $\ell = m - 1, \dots, 1$ whether the period ℓ forms a new active outbar for the following periods $n = \ell - 1, \dots, 0$.

In order to validate that the period ℓ is a new active outbar, we have to check Definition 2.1 in that situation. That means

(a) the period $n = \ell - 1$ forms an initializing inbar to the forerunner period $n = \ell$, i.e.

$$\begin{aligned}
\max \{ Open[\ell - 1], Close[\ell - 1] \} &\leq High[\ell] + \$param_outbar_ini \\
\min \{ Open[\ell - 1], Close[\ell - 1] \} &\geq Low[\ell] - \$param_outbar_ini
\end{aligned}$$

and furthermore

(b) the periods $n = \ell - 2, \dots, 0$ are following inbars to the outbar ℓ , i.e. using

$$\begin{aligned}
maxi(n) &:= \max \{ Open[n], Close[n] \}, \\
mini(n) &:= \min \{ Open[n], Close[n] \}
\end{aligned}$$

and the definitions

$$\begin{aligned}
usualinbar(n) &:= (maxi(n) \leq High[\ell] + \$param_outbar) \\
&\text{and} \\
&(mini(n) \geq Low[\ell] - \$param_outbar), \\
goodclose(n) &:= (Close[n] \leq High[\ell]) \text{ and } (Close[n] \geq Low[\ell]), \\
broadinbar(n) &:= (maxi(n) \leq High[\ell] + \$param_close_inside) \\
&\text{and} \\
&(mini(n) \geq Low[\ell] - \$param_close_inside)
\end{aligned}$$

we require

$$usualinbar(n) \text{ or } (goodclose(n) \text{ and } broadinbar(n)) \text{ for all } n = \ell - 2, \dots, 0$$

to be true.

The largest period $\ell \leq m - 1$ (i.e. the oldest of these periods) which satisfies these conditions is called **renewed active outbar** and all the followers are **inbars**.

If no renewed active outbar can be found, we have no active outbar until one of the subsequent periods forms again an initializing inbar to its forerunner period as described in Definition 2.1.

Remark 2.3 Usually the price process is known or stored only for a finite number of periods. Clearly, our calculation can only recognize outbars within the known periods of the price process. Nevertheless, the unknown earlier price process may have outbars with consecutive inbars reaching into the time frame of our calculation. However, without loading more price data, these inbars can not be recognized.

Below, we define the direction process that will indicate up- and down-movements. We distinguish the cases when no outbar is active from cases with an active or a renewed active outbar. If the current period $n = 0$ is not an inbar,

$$mini = \min \{Open[0], Close[0]\} \text{ and } maxi = \max \{Open[0], Close[0]\}$$

satisfy compared to the forerunner period

$$maxi > High[1] \text{ or } mini < Low[1]. \quad (2)$$

Hence, the next definition makes sense.

Definition 2.4 (Direction when no outbar is active)

If the current period $n = 0$ is not an inbar, we set

$Direction[0] := 1$, in case

$$maxi > High[1] \text{ and } \left((mini \geq Low[1]) \text{ or } \left((mini < Low[1]) \text{ and } (Close[0] > Open[0]) \right) \right)$$

$Direction[0] := -1$, in case

$$mini < Low[1] \text{ and } \left((maxi \leq High[1]) \text{ or } \left((maxi > High[1]) \text{ and } (Close[0] < Open[0]) \right) \right)$$

Note that, due to (2), exactly one of the two conditions in Definition 2.4 is valid, giving well definiteness. We intend to define the direction process for all periods as $Direction = 1$ for up-movements and $Direction = -1$ for down-movements. However, to initialize this process, we start with $Direction = 0$ for the first known bars of the price process until we find a first period that is not an inbar to its forerunner period and hence can apply Definition 2.4.

We still have to define the direction process when an outbar is active. To clearly differentiate this from situations with no outbar, we use $\pm 1/2$ as values for the direction process. In particular, $Direction = 1/2$ stands for an up-movement with an outbar correction and analogously $Direction = -1/2$ stand for a down-movement with an outbar correction.

Definition 2.5 (Direction for an active outbar, that is not renewed)

In case the current period $n = 0$ is an inbar to the active outbar $n = m$, which is not a renewed outbar, the sign of the direction process stays unchanged, i.e. we set

$$Direction[0] := \begin{cases} Direction[1], & \text{if } |Direction[1]| < 1, \\ Direction[1]/2, & \text{if } |Direction[1]| = 1. \end{cases}$$

If the active outbar is a renewed outbar (cf. Definition 2.2), the current bar is an inbar, but the former active outbar $n = m$ was broken by the current period. Hence, the direction in which the outbar was broken indicates the current movement.

Letting again $mini = \min \{Open[0], Close[0]\}$ and $maxi = \max \{Open[0], Close[0]\}$, we have

$$maxi > High[m] \text{ or } mini < Low[m]. \tag{3}$$

Definition 2.6 (Direction for a renewed outbar)

If the current period $n = 0$ is an inbar to a renewed outbar and simultaneously no longer an inbar to the former active outbar $n = m$, we set

$Direction[0] := 1/2$, in case

$$maxi > High[m] \text{ and } \left[(mini \geq Low[m]) \text{ or } \left((mini < Low[m]) \text{ and } (Close[0] > Open[0]) \right) \right],$$

and

$Direction[0] := -1/2$, in case

$$mini < Low[m] \text{ and } \left[(maxi \leq High[m]) \text{ or } \left((maxi > High[m]) \text{ and } (Close[0] < Open[0]) \right) \right].$$

Again (3) yields well definiteness.

Remark 2.7 *Definitions 2.4, 2.5 and 2.6 define the direction process for all periods. After an initialization phase in which $Direction = 0$, the direction process always indicates either an up-movement ($Direction = +1$ or $+1/2$) or a down-movement ($Direction = -1$ or $-1/2$).*

The so-defined direction process can be used as stop and reverse indicator, that changes position each time the sign of $Direction$ is changed. We call this indicator **InOutBars SAR**. In Figure 3, we show the direction process for the price evolution according to Figure 1 in bold. The light curve visualizes the distance to the last outbar, if any is present.

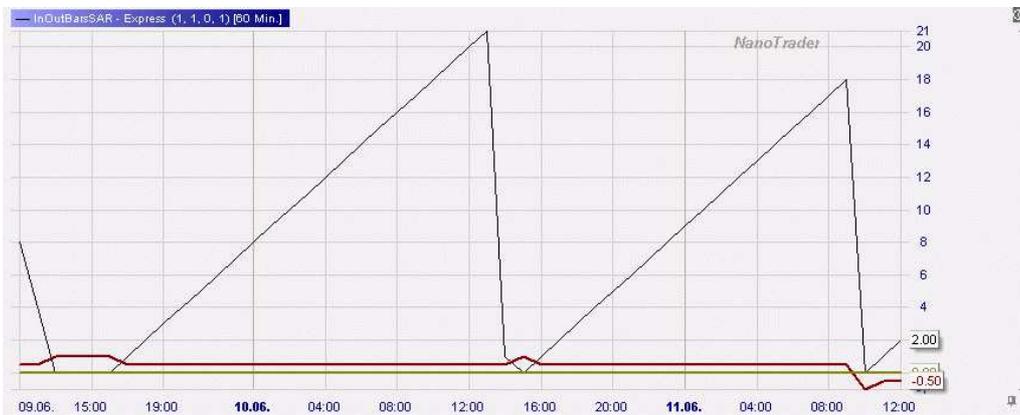


Figure 3: Direction process and distance to last outbar for the price process in Fig. 1

The parameters used in Figure 3 are $\$param_outbar_ini = 1$, $\$param_outbar = 2$, $\$param_close_inside = 6$ and $\$factor = 1$. The parameter $\$factor$ may be used to simultaneously scale all the other three parameters in (1). If $\$factor = 1$ or if $\$factor$ is suppressed at all, the parameters in (1) are in ticksize. Note that in order to recognize the 15 o'clock candle on June 10th of Figure 1 as outbar, it is necessary to have $\$param_outbar_ini > 0$, because the body of the 16 o'clock candle is not completely inside the range of the 15 o'clock candle. Similar to other SAR processes the so built trading strategy would be invested all the time, which is *not recommended*. It may, however, be used in trend phases to indicate the end of a correction. Another more suited application is to use InOutBars SAR as stop to guard positions when the price process is in movement.

When InOutBars SAR is used at the end of each period, there is a calculation of the new direction that may or may not imply a reversal of the current position. So far, no intra-period guarding is present. Therefore, it is recommended to complement InOutBars SAR with a further intra-period stop strategy which will be introduced in the next section.

3 The Stop Process StopInOutBars

In this section, we introduce a complementary intra-period stop strategy for the InOutBars SAR indicator. We intend to calculate two time series,

$$\text{StopSeriesLow} \quad \text{and} \quad \text{StopSeriesHigh} ,$$

which are evaluated at the end of a period. If we have an open long position, we use the calculated value of StopSeriesLow as intra-period stop for the following period. Similarly, StopSeriesHigh is used to guard a short position on an intra-period basis.

The stop strategy distinguishes between phases when no outbar is active and phases with an active outbar. For the first one we need the parameter

$$\text{\$nonoutbar_dist} \geq 0.$$

Definition 3.1 (Stop Series for non outbar phases)

If the current period $n = 0$ is not an inbar, we set

$$\begin{aligned} \text{StopSeriesLow}[0] &= \text{Low}[0] - \text{\$nonoutbar_dist} \\ \text{StopSeriesHigh}[0] &= \text{High}[0] + \text{\$nonoutbar_dist} \end{aligned}$$

for guarding a position through the next period on an intra-period level.

The idea behind that stop is that we intend to guard positions that are in a strong movement. As long as this movement persists for long positions a stop below the low of the forerunner period is suited (similarly above the forerunner's high for shorts positions). The parameter `\$nonoutbar_dist` may be chosen to be non-zero in case some more tolerance is appreciated.

To guard positions in phases with active outbar present, we introduce the parameters

$$\begin{aligned} 0 &\leq \text{\$forerunner_outbar_dist} \quad \text{and} \\ 0 &\leq \text{\$stop_param_mindist} \leq \text{\$stop_param_maxdist} . \end{aligned}$$

In case of an active outbar, it happens quite often that the following bars acquire highs far beyond the high of the outbar while nevertheless fall short to close within the range of the outbar, thus yielding inbars. Similarly such intra-period outbreaks occur for inbars on the lower side.

Here, it is essential to guard the position not too closely, in order to prevent an early cancelation of the position just due to market fluctuations. Therefore, the position is guarded with a stop near the high/low of the forerunner of the active outbar m ,

$$\begin{aligned} \text{temp_lowstop}(m) &:= \text{Low}[m + 1] - \text{\$forerunner_outbar_dist} , \\ \text{temp_highstop}(m) &:= \text{High}[m + 1] + \text{\$forerunner_outbar_dist} , \end{aligned}$$

unless this stop is too close or too far from the high/low of the outbar. More precisely, we define

$$\begin{aligned} \ell_{\text{mind}}(m) &:= \text{Low}[m] - \$\text{stop_param_mindist}, \\ \ell_{\text{maxd}}(m) &:= \text{Low}[m] + \$\text{stop_param_maxdist}, \\ h_{\text{mind}}(m) &:= \text{High}[m] - \$\text{stop_param_mindist}, \\ h_{\text{maxd}}(m) &:= \text{High}[m] + \$\text{stop_param_maxdist}. \end{aligned}$$

Definition 3.2 (Stop Series for outbar phases)

If the current period $n = 0$ is an inbar for the outbar m , we set

$$\text{StopSeriesLow}[0] := \begin{cases} \ell_{\text{mind}}(m), & \text{if } \text{temp_lowstop}(m) > \ell_{\text{mind}}(m) \\ \text{temp_lowstop}(m), & \text{if } \text{temp_lowstop}(m) \in [\ell_{\text{maxd}}(m), \ell_{\text{mind}}(m)] \\ \ell_{\text{maxd}}(m), & \text{if } \text{temp_lowstop}(m) < \ell_{\text{maxd}}(m) \end{cases}$$

and

$$\text{StopSeriesHigh}[0] := \begin{cases} h_{\text{maxd}}(m), & \text{if } \text{temp_highstop}(m) > h_{\text{maxd}}(m) \\ \text{temp_highstop}(m), & \text{if } \text{temp_highstop}(m) \in [h_{\text{mind}}(m), h_{\text{maxd}}(m)] \\ h_{\text{mind}}(m), & \text{if } \text{temp_highstop}(m) < h_{\text{mind}}(m) \end{cases}.$$

The minimal distance to the outbar’s high/low is necessary to stay away from market fluctuations while the outbar is active. The maximal distance, however, may be desired by the investor to restrict the maximal risk an open position is able to attain.

The stop procedure guarding positions according to StopSeriesLow and StopSeriesHigh is called **StopInOutBars**. As already noted, this stop is calculated at the end of a period for possible striking through the whole next period on an intra-period basis.

In case a position is opened intra-period, similarly the value of StopSeriesLow/High calculated at the end of the forerunner period is used for guarding through the entry-period. In Figure 4, we see a long position that is guarded by StopInOutBars during an up-movement. We observe three outbars (indicated by lines through their highs). Furthermore, StopSeriesLow is plotted as well. The only non-zero parameter that is used is $\text{\$stop_param_maxdist} = 100$.

4 Statistics

In this section, we intend to give some examples how InOutBars SAR may be used.

As noted earlier, this indicator is especially helpful when the market is in movement. Therefore to construct a reliable test situation, we first have to define some simple entry setup that guarantees

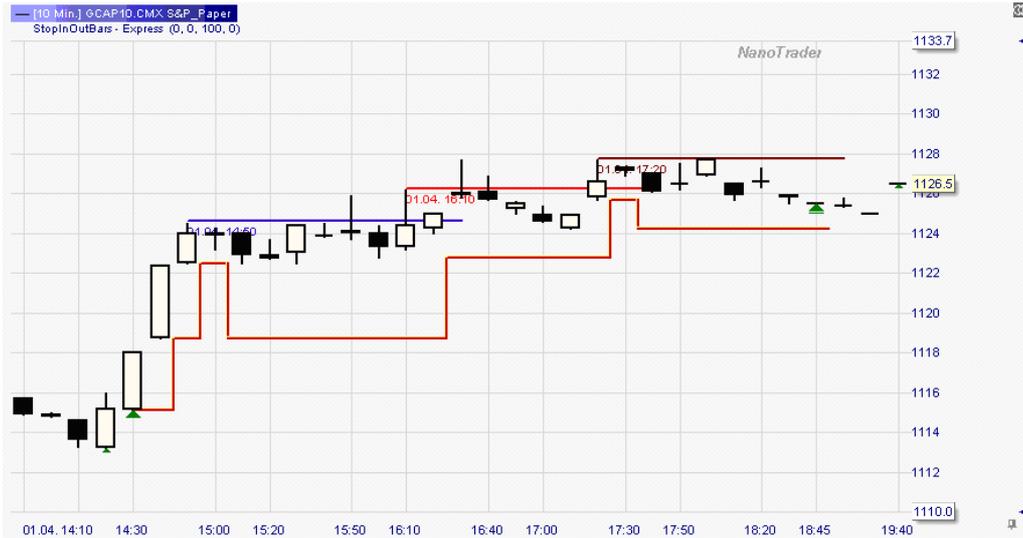


Figure 4: StopSeries from StopInOutBars

this movement. We note that the usage of simple crossing moving averages has not been sufficient to provide enough movement. Below, we will distinguish the long and the short setup. As long setup we used an "instant volatility and breakout" strategy while the short setup used simple "breakouts" with "stop sell orders".

All trades are generated on a 10-minute period basis. To recognize whether to use the long or the short setup, we used a very rough daily trend filter called *trendcheckers*¹. Since we only need the daily trend, this could also be decided by hand. Nevertheless *trendcheckers* works on any time unit and decides trends automatically but this is not necessary for our tests. When applied to crude oil during the 1000 days preceding this study, i.e. between July 6th, 2007 and April 1st, 2010 only three daily trend periods are present. Starting with an up-bias in 2007, crude oil reached a high of almost 150\$ in summer 2008 and ended this up phase according to our trend filter on September 1st, 2008. The following down phase lasted until May 5th, 2009 and until today, the oil market is again in an up phase (cf. Figures 5 and 6).



Figure 5: Two up-phases and the intermediate down-phase (01.09.08 till 05.05.09) in crude oil

All trades are reported with a 5\$ commission fee for the halfturn. At the moment, we neglect any possible slippage but include this issue in Subsection 4.4. The calculations are performed using the Nanotrader by Fipertec (cf. [2]). All statistical tests are made on the May 2010 future of crude oil at CME. The reported prices are for one contract of 1000 barrels of crude oil. A very simple idea on breakout setups is described in [5], Chapter 17, breakout systems. In order to generate big moves,

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however, we will be more selective in the context.

4.1 Long Setup

The entry setup for *instant volatility and breakout* for long positions uses four parameters $(\ell, m, n, N) = (10, 2, 2, 25)$ and a threshold vector

$$\alpha = (\alpha_1, \alpha_2, \alpha_3) := \left(\frac{3}{10}, \frac{3}{5}, \frac{25}{10000} \right).$$

We need a vector measuring the difference of recent market prices. Using $\text{minclosediff} := \min \{ \text{Close}[0] - \text{Close}[1], \text{Close}[0] - \text{Open}[0] \}$, we set

$$\text{diff}(m, \ell) = \begin{pmatrix} \text{diff}_1(m) \\ \text{diff}_2(\ell) \\ \text{diff}_3 \end{pmatrix} := \begin{pmatrix} (\text{Close}[0] - \text{Open}[m]) / \sum_{i=0}^m |\text{High}[i] - \text{Low}[i]| \\ \text{minclosediff} / \text{ATR}(\ell) \\ \text{minclosediff} / \text{Close}[0] \end{pmatrix},$$

where $\text{ATR}(\ell)$ is the average true range of the last ℓ periods. If this difference vector has sufficiently large components, we call it a "big white bar":

$$\text{bigwhitebar}(\alpha, \ell, m) := (\text{diff}_1(m) > \alpha_1) \text{ and } (\text{diff}_2(\ell) > \alpha_2) \text{ and } (\text{diff}_3 > \alpha_3).$$

Here, diff_1 and diff_2 measure the recent movement in relation to volatility, whereas diff_3 compares the recent movement to the absolute value of the underlying price. Furthermore we use a "new period high indicator" on N periods, i.e.

$$\text{newperiodhigh}(N) = \left(\text{Close}[0] > \max_{i=1, \dots, N} \text{High}[i] \right),$$

and for $n < N$

$$\text{breakout}(n, N) = \text{newperiodhigh}(N) \text{ and } \left(\max_{i=1, \dots, n} \text{High}[i] < \max_{i=1, \dots, N} \text{High}[i] \right)$$

indicates a breakout situation for the current period. We obtain a setup for a long position if

$$\text{setuplong}(\alpha, \ell, m, n, N) := \left(\text{bigwhitebar}(\alpha, \ell, m) \text{ and } \text{breakout}(n, N) \text{ and } (\text{Direction}_{(0,2,6)}[0] > 0) \right)$$

is true. The position is established during the next period if the price reaches the high of the current setup period ("confirmation during next bar"). Note that no matter what stop we use to exit the position, the entry signal $\text{setuplong}()$ always uses InOutBars SAR with parameters $(0, 2, 6)$ (cf. Table 1, Vers 2) on ticksize basis. Since we have fixed the entry signal, we may now describe the various stops we use.

The first four columns of Table 2 contain statistical data for end of period (*EoP*) stops generated by InOutBars SAR with four different sets of parameters (see Table 1; all values in ticksize, i.e. 1ct. for crude oil).

InOutBars SAR	Vers 1	Vers 2	Vers 3	Vers 4
\$param_outbar_ini	0	0	0	2
\$param_outbar	0	2	4	4
\$param_close_inside	6	6	6	6

Table 1: Parameters for InOutBars SAR

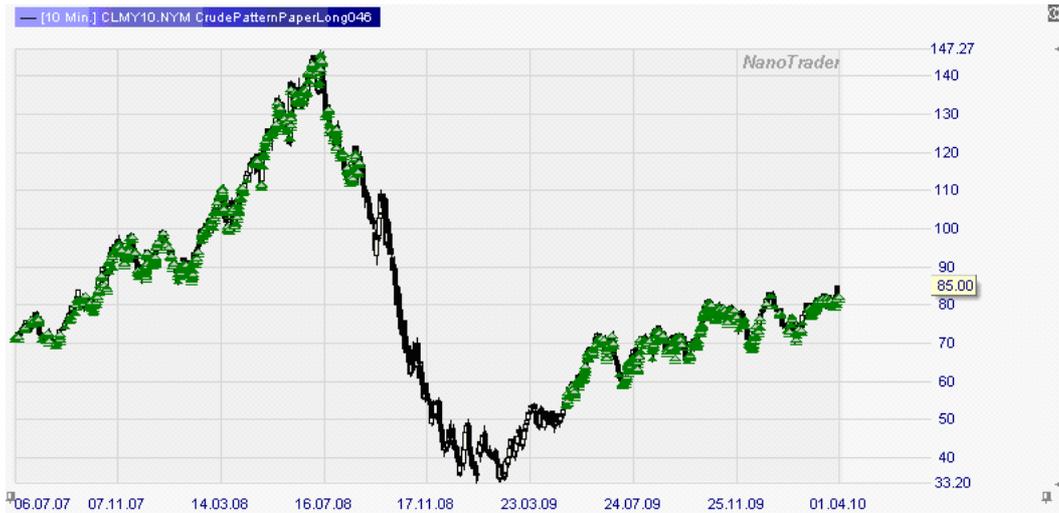


Figure 6: Long setup for InOutBars SAR Vers 3 on crude oil

For instance, the parameters of Version 3 generated the chart in Figure 6

with equity curve show in Figure 7 (right). Note that there are no trades in the down phase shown in Figure 5. Vers 3 had a total gain of 56580\$, a maximal drawdown of 3759\$ (cf. Table 2) and a steady rising equity curve.

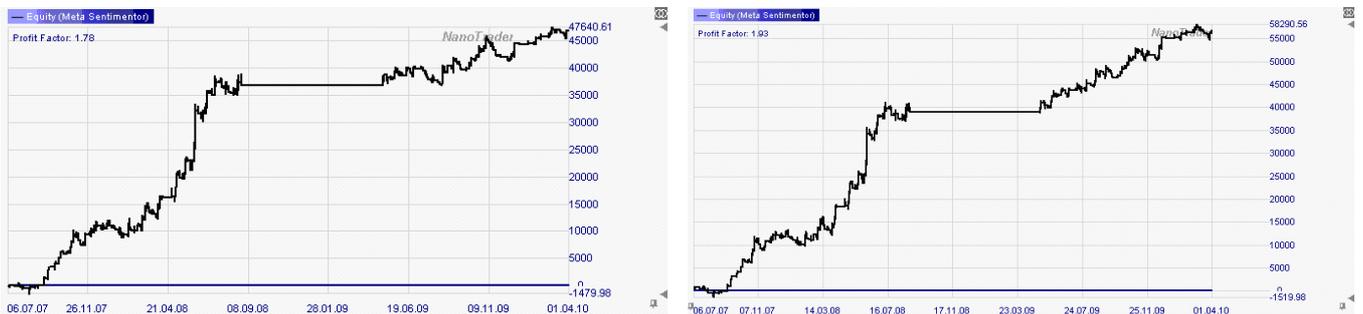


Figure 7: Equity curve for long setup: InOutBars Vers 1 (left) and Vers 3 (right)

The other versions of InOutBars SAR yield similar, almost as good equity curves (see for example Vers 1 in Figure 7 (left)). For comparison to other standard stops, in Table 2, we also included data for two *TrailStops* and *PerHighLow* with 10 periods. The *TrailStop* is applied with either 60 Cents or 40 Cents trailing distance (see Figure 8 (left)). All seven stops are evaluated on an end of period

Long Setup, all stops EoP	InOutBars SAR				TrailStop		PerHighLow 10 periods
	Vers 1	Vers 2	Vers 3	Vers 4	60 Cents	80 Cents	
total net profit:	46.800,60	47.120,60	56.580,55	53.390,57	60.950,55	44.370,59	56.810,55
total # of trades:	323	317	305	303	280	309	286
winning trades:	133	137	138	136	129	129	131
losing trades:	190	180	167	167	151	180	155
percent profitable: p	41,18%	43,22%	45,25%	44,88%	46,07%	41,75%	45,80%
profit factor:	1,78	1,77	1,93	1,85	1,82	1,71	1,67
avg win/avg loss:	2,54	2,33	2,33	2,27	2,13	2,39	1,98
Expectation (Avg trade, win & loss): $\hat{\mu}$	144,89	148,65	185,51	176,21	217,68	143,59	198,64
percent in the market:	5,35%	5,81%	6,74%	6,94%	12,40%	7,09%	8,40%
gross profit:	106.730,20	108.340,20	117.700,19	116.480,20	135.130,19	106.650,20	141.410,22
gross loss:	59.929,61	61.219,60	61.119,64	63.089,63	74.179,64	62.279,61	84.599,67
largest winning trade:	6.190,00	6.190,00	6.190,00	6.190,00	3.650,00	3.610,00	7.050,01
"-" in percent:	13,23%	13,14%	10,94%	11,59%	5,99%	8,14%	12,41%
avg winning trade: $\hat{\mu}_{win}$	802,48	790,80	852,90	856,47	1.047,52	826,75	1.079,47
avg # bars in winners:	27,91	30,18	35,66	37,11	70,19	37,05	44,82
largest losing trade:	1.649,98	1.649,98	1.649,98	1.649,98	1.609,98	850,00	2.210,00
avg losing trade: $\hat{\mu}_{loss}$	315,42	340,11	365,99	377,78	491,26	346,00	545,80
avg # bars in losers:	8,02	8,68	10,13	10,52	20,59	12,08	15,24
max consecutive winners:	6	6	5	5	7	8	5
max consecutive losers:	9	9	6	6	7	10	6
Std.Dev. all trades: $\hat{\sigma}$	833,41	844,92	896,55	906,13	986,32	765,35	1.133,76
Std.Dev. winning trades: $\hat{\sigma}_{win}$	920,49	908,18	930,22	938,52	867,68	739,85	1.076,69
Std.Dev. losing trades: $\hat{\sigma}_{loss}$	272,54	278,90	285,72	299,22	262,36	197,77	427,16
max drawdown:	4.409,96	4.839,96	3.759,96	3.879,95	5.129,97	3.819,96	5.819,99
Commission paid:	3.230,00	3.170,00	3.050,00	3.030,00	2.800,00	3.090,00	2.860,00
Performance/Drawdown:	10,61	9,74	15,05	13,76	11,88	11,62	9,76
evaluation start:	Fri 06.07.07,	00:00 a.m					
evaluation stop:	Thu 01.04.10,	03:50 p.m					

Table 2: Statistics for InOutBars SAR, TrailStop, PerHighLow (long setup, all EoP)

basis. At first glance it seems that the TrailStop 60 Cents outperforms the InOutBars SAR stops and PerHighLow (10 periods) is equal up in total net profit with the performance of InOutBars SAR Vers 3. However, both methods have about 50% larger average losing trades $\hat{\mu}_{loss}$ and their maximal drawdowns are also seriously higher. Using a smaller trail stop of 40 Cents, the two mentioned statistical values can be lowered to the range of what InOutBars SAR obtained. This would, in turn, result in a much smaller total net profit.

Table 4 contains data for a backtest using the *Parabolic SAR* with standard parameters (10, 0.02, 0.2) as stop on an *EoP* basis. Furthermore, we include data for a stop called *Voigt stop* which is also based on the idea of outbars and inbars. This stop is available through *WH Selfinvest*. For the description of the other stops confer [2] or [4].

The Voigt stop is used on an intra-period basis and as *EoP* stop. Additionally, we include two applications of the stop series generated by StopInOutBars (each on intra-period basis as well as

EoP; the used parameters are listed in Table 3). All four applications of StopInOutBars are used in combination with InOutBars SAR Vers 2 for *EoP* stop exits. The equity curve for our Standard *EoP* version of StopInOutBars is given in Figure 8 (right).

StopInOutBars	Original	Standard
\$nonoutbar_dist	0	2
\$stop_param_mindist	0	5
\$stop_param_maxdist	100	25
\$forerunner_outbar_dist	0	0

Table 3: Parameters of StopInOutBars



Figure 8: Equity curve for long setup: TrailStop 60 Cent (left) and Standard *EoP* (right)

Compared to using InOutBars SAR Vers 2 alone as stop the intra-period stops of StopInOutBars loose ground, whereas the *EoP* stops based on StopInOutBars are comparable with even better maximal drawdown. We would like to point out that the parameters of StopInOutBars are by no means optimized.

4.2 Short Setup

Of course the *instant volatility and breakout* strategy of Subsection 4.1 could in principle be traded on the short side as well. However, since instant breakdowns on the short side are much more aggressive than those on the long side, in many cases at the end of a period a big part of the movement has already taken place. To overcome that problem for the short setup, we suggest a simple "breakout and stop sell" strategy which acts intra-period, when recent lows break. Since we want to be stopped into the market on an intra-period basis, in each current period, firstly, we have to decide whether our breakout setup is valid and, secondly, calculate a short trigger as short stop value for the next period. We work with three parameters $(N, N_1, N_2) = (30, 3, 15) \in \mathbb{N}^3$. N is the total number of

Long Setup	Parabolic EoP	Voigt Stop Intra	Voigt Stop EoP	Standard Intra	Standard EoP	Original Intra	Original EoP
total net profit:	36.100,62	45.509,97	50.600,56	32.830,06	47.200,57	33.200,12	45.110,55
total # of trades:	322	315	301	318	312	320	312
winning trades:	159	153	135	138	138	140	138
losing trades:	163	162	166	180	174	180	174
percent profitable: p	49,38%	48,57%	44,85%	43,40%	44,23%	43,75%	44,23%
profit factor:	1,49	1,79	1,71	1,57	1,73	1,57	1,69
avg win/avg loss:	1,53	1,90	2,11	2,05	2,19	2,02	2,13
Expectation (Avg trade, win & loss): $\hat{\mu}$	112,11	144,48	168,11	103,24	151,28	103,75	144,59
percent in the market:	4,44%	5,70%	7,88%	5,05%	6,47%	4,91%	6,35%
gross profit:	110.090,24	102.840,01	121.460,22	90.600,00	111.450,20	91.010,03	110.530,19
gross loss:	73.989,63	57.330,04	70.859,66	57.769,94	64.249,64	57.809,91	65.419,64
largest winning trade:	3.770,00	6.549,99	6.360,01	6.090,00	6.960,00	7.070,00	6.960,00
-"- in percent:	10,44%	14,39%	12,57%	18,55%	14,75%	21,30%	15,43%
avg winning trade: $\hat{\mu}_{win}$	692,39	672,16	899,70	656,52	807,61	650,07	800,94
avg # bars in winners:	17,18	24,59	39,95	24,73	33,15	23,64	32,41
largest losing trade:	2.140,00	1.620,00	2.070,00	1.690,00	1.649,98	1.550,00	2.070,00
avg losing trade: $\hat{\mu}_{loss}$	453,92	353,89	426,87	320,94	369,25	321,17	375,98
avg # bars in losers:	9,93	11,26	14,06	8,37	10,18	8,34	10,10
max consecutive winners:	8	8	8	6	6	8	6
max consecutive losers:	13	8	7	6	7	6	6
Std.Dev. all trades: $\hat{\sigma}$	804,09	804,29	990,06	744,75	893,24	769,03	893,80
Std.Dev. winning trades: $\hat{\sigma}_{win}$	695,61	835,19	1.031,94	799,82	958,33	848,90	949,54
Std.Dev. losing trades: $\hat{\sigma}_{loss}$	395,43	297,58	351,21	275,17	301,52	281,73	325,49
max drawdown:	5.859,99	3.190,02	5.799,96	4.439,99	3.859,96	4.290,01	3.819,96
Commission paid:	3.220,00	3.150,00	3.010,00	3.180,00	3.120,00	3.200,00	3.120,00
Performance/Drawdown:	6,16	14,27	8,72	7,39	12,23	7,74	11,81
evaluation start:	Fri 06.07.07,	00:00 a.m					
evaluation stop:	Thu 01.04.10,	03:50 p.m					

Table 4: Statistics for Parabolic EoP, Voigt Stop and StopInOutBars (long setup)

recent periods in our consideration. We set

$$\text{LastLow}(N) := \min_{i=0, \dots, N-1} \text{Low}[i]$$

and

$$\text{LastLowTime}(N) := \text{index of the last (most recent) low within } N \text{ periods } \in [0, N - 1].$$

Our breakout setup is valid once

$$\begin{aligned} \text{PossibleShortEntry}(N, N_1, N_2) := & \left(\text{LastLowTime}(N) \in (N_1, N - N_2) \right) \\ & \text{and } (\text{Direction}_{(0,2,6)}[0] < 0) \\ & \text{and } (\text{Close}[0] < \text{Open}[0]) \end{aligned} \tag{4}$$

is true. As short trigger for the next period on an intra-period basis, we use $\text{LastLow}(N)$. Hence, we have to use "Confirmation price next bar" as enter sentiment. Note that we used the direction process of the InOutBars SAR process. To fix the entry signal, we always use the parameters of Table 1 Vers 2. We do not pay any attention to a possible counter signal based on the above idea. Furthermore, the InOutBars SAR Vers 2 does not create any stop signals. The described enter signal will be the same for all the following tests. Thus we can compare the different stops. As in Subsection 4.1, the following statistical tests are done on the crude oil May 2010 contract with 1000 barrels and 5\$ commission for the halfturn on the 10-minute chart, however, now in the down market phase from September 1st, 2008 to May 5th, 2009 (cf. Figure 5).

The first four steps of Table 5 use InOutBars SAR on an end of period basis with the parameters as described in Table 1. Here, the parameter values of Vers 2 worked best with a gain of 22170\$ and a maximal drawdown of 6200\$ but also the other parameter values work reasonably. In Figure 9, we have the corresponding chart of Vers 2 and its equity curve is in Figure 10 (left) next to the equity curve of Vers 4.

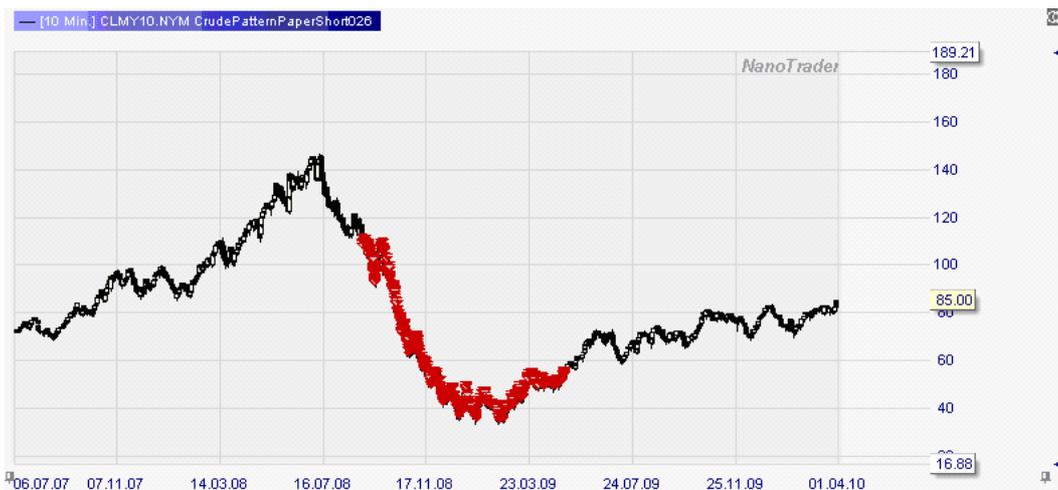


Figure 9: Short setup for InOutBars SAR Vers 2 as stop (trades only in the down phase)

Short Setup, all stops <i>EoP</i>	InOutBars SAR				TrailStop		PerHighLow
	Vers 1	Vers 2	Vers 3	Vers 4	60 Cents	80 Cents	10 periods
total net profit:	18.989,80	22.169,82	20.099,82	17.729,80	16.209,82	22.549,84	29.619,84
total # of trades:	179	169	165	168	158	138	147
winning trades:	85	80	78	79	73	66	63
losing trades:	94	89	87	89	85	72	84
percent profitable: p	47,49%	47,34%	47,27%	47,02%	46,20%	47,83%	42,86%
profit factor:	1,54	1,64	1,56	1,47	1,37	1,50	1,65
avg win/avg loss:	1,70	1,83	1,75	1,66	1,60	1,63	2,20
Expectation (Avg trade, win & loss): $\hat{\mu}$	106,09	131,18	121,82	105,53	102,59	163,40	201,50
percent in the market:	2,23%	2,37%	2,56%	2,64%	3,82%	5,24%	3,70%
gross profit:	54.179,90	56.679,90	55.689,90	55.109,89	59.829,89	67.829,92	75.289,92
gross loss:	35.190,10	34.510,07	35.590,09	37.380,09	43.620,07	45.280,08	45.670,08
largest winning trade:	2.569,99	4.230,00	4.230,00	4.230,00	3.549,99	3.600,00	5.739,99
"-" in percent:	13,53%	19,08%	21,04%	23,86%	21,90%	15,96%	19,38%
avg winning trade: $\hat{\mu}_{win}$	637,41	708,50	713,97	697,60	819,59	1.027,73	1.195,08
avg # bars in winners:	18,15	19,59	21,28	21,48	32,92	52,02	39,32
largest losing trade:	1.560,00	1.560,00	1.560,00	1.560,00	1.360,00	1.360,00	2.090,00
avg losing trade: $\hat{\mu}_{loss}$	374,36	387,75	409,08	420,00	513,18	628,90	543,69
avg # bars in losers:	6,81	8,47	9,75	9,97	15,78	23,65	13,75
max consecutive winners:	7	7	7	7	6	6	7
max consecutive losers:	6	8	9	8	10	5	12
Std.Dev. all trades: $\hat{\sigma}$	700,81	779,53	792,72	786,57	848,11	1.067,74	1.164,28
Std.Dev. winning trades: $\hat{\sigma}_{win}$	620,65	731,12	736,83	721,58	721,28	914,54	1.079,43
Std.Dev. losing trades: $\hat{\sigma}_{loss}$	317,41	323,86	330,30	344,37	260,82	321,14	450,32
max drawdown:	6.590,07	6.200,05	7.100,03	6.930,03	6.840,04	5.580,00	7.660,04
Commission paid:	1.790,00	1.690,00	1.650,00	1.680,00	1.580,00	1.380,00	1.470,00
Performance/Drawdown:	2,88	3,58	2,83	2,56	2,37	4,04	3,87
evaluation start:	Fri 06.07.07,	00:00 a.m					
evaluation stop:	Thu 01.04.10,	03:50 p.m					

Table 5: Statistics for InOutBars SAR, TrailStop and PerHighLow all *EoP* (short setup)

Further stops of Table 5 are TrailStop (60 Cents and 80 Cents) and PerHighLow (10 periods) (see Figure 11 (left)). Other standard stops such as Parabolic SAR *EoP* and Voigt Stop (intra-period and *EoP*) are given in Table 6.

We find that both PerHighLow and the Voigt Stop *EoP* outperform all InOutBars SAR stops of Table 5, however, with enlarged maximal drawdown and average losing trade $\hat{\mu}_{loss}$. The Voigt Stop Intra clearly falls short compared to the Voigt Stop *EoP*.

As for the long setup, also here, the TrailStop *EoP* becomes better when the trailing distance is enlarged. But note that the larger the trailing distance, the further away is the average losing trade from the value we achieve for InOutBars SAR.

The remaining four stops in Table 6 use InOutBars SAR Vers 2 *EoP* as basic stop combined with StopInOutBars intra-period or *EoP* with parameters as in Table 3. The additional application

Short Setup	Parabolic EoP	Voigt Stop Intra	Voigt Stop EoP	Standard Intra	Standard EoP	Original Intra	Original EoP
total net profit:	16.339,81	16.800,02	24.379,82	21.620,01	23.399,82	19.450,01	24.039,83
total # of trades:	176	178	161	170	166	174	165
winning trades:	82	75	72	83	75	84	75
losing trades:	94	103	89	87	91	90	90
percent profitable: p	46,59%	42,13%	44,72%	48,82%	45,18%	48,28%	45,45%
profit factor:	1,37	1,45	1,65	1,67	1,68	1,60	1,69
avg win/avg loss	1,57	2,00	2,04	1,75	2,03	1,71	2,03
Expectation (Avg trade, win & loss): $\hat{\mu}$	92,84	94,38	151,43	127,18	140,96	111,78	145,70
percent in the market:	2,18%	2,14%	3,15%	2,11%	2,71%	2,04%	2,64%
gross profit:	61.069,89	53.879,99	62.069,91	53.910,01	58.049,92	52.030,00	58.629,93
gross loss:	44.730,08	37.079,98	37.690,10	32.290,00	34.650,10	32.579,99	34.590,11
largest winning trade:	2.660,00	3.470,00	5.479,99	4.300,00	4.810,00	4.300,00	4.810,00
"-" in percent:	16,28%	20,65%	22,48%	19,89%	20,56%	22,11%	20,01%
avg winning trade: $\hat{\mu}_{win}$	744,76	718,40	862,08	649,52	774,00	619,41	781,73
avg # bars in winners:	15,66	16,65	31,21	17,06	22,83	15,45	22,04
largest losing trade:	1.360,00	1.179,99	1.620,00	1.559,99	1.560,00	1.410,00	1.560,00
avg losing trade: $\hat{\mu}_{loss}$	475,85	360,00	423,48	371,15	380,77	362,00	384,34
avg # bars in losers:	9,06	8,25	9,49	7,49	10,44	7,78	10,34
max consecutive winners:	6	7	6	9	5	9	5
max consecutive losers:	12	7	15	8	12	6	8
Std.Dev. all trades: $\hat{\sigma}$	816,72	732,97	915,75	755,24	821,88	734,35	828,18
Std.Dev. winning trades: $\hat{\sigma}_{win}$	687,27	695,88	905,62	724,47	792,85	712,61	794,29
Std.Dev. losing trades: $\hat{\sigma}_{loss}$	377,05	293,51	339,88	325,41	335,19	323,22	338,08
max drawdown:	6.520,05	6.730,02	8.490,05	6.120,00	7.460,04	5.920,00	8.760,04
Commission paid:	1.760,00	1.780,00	1.610,00	1.700,00	1.660,00	1.740,00	1.650,00
Performance/Drawdown:	2,51	2,50	2,87	3,53	3,14	3,29	2,74
evaluation start:	Fri 06.07.07,	00:00 a.m					
evaluation stop:	Thu 01.04.10,	03:50 p.m					

Table 6: Statistics for Parabolic EoP , Voigt Stop and StopInOutBars (short setup)

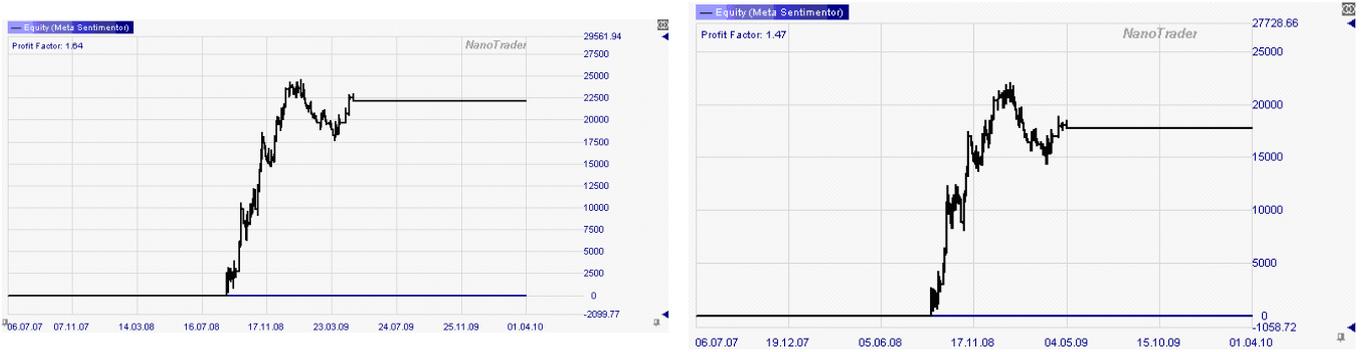


Figure 10: Equity curves for short setup: InOutBars SAR Vers 2 (left) and Vers 4 (right)



Figure 11: Equity curves for short setup: PerHighLow (left) and Original EoP (right)

of StopInOutBars, at least on *EoP* basis, improved the result from solely using InOutBars SAR Vers 2 alone (cf. Figure 11 (right)). As in the long setup, we did not optimize the parameters of StopInOutBars.

4.3 InOutBars SAR as Entry

As every SAR system, InOutBars SAR may be also be used to generate entry signals. Using entry and stop signals of such SAR systems, these systems are always invested in one or the other direction. They typically fall short in volatile sideways markets. Hence, their usage without additional filters is not recommended.

Nevertheless, with filters, the result may be performing positively, as we see in the last series of tests. We use the same filter to preselect when to trade long positions and when to trade short positions on the 10-minute chart (cf. Figure 5) but consider the whole period of 1000 days in total. Hence, in the period from September 1st, 2008 to May 5st, 2009 only short positions are traded while for the rest of time only long positions are used. The first five tests of Table 7 use InOutBars SAR Vers 2 as entry signal (long as well as short positions) for the crude oil contract that was already used in Subsections 4.1 and 4.2 (still 5\$ commission for the halfturn).

As exit in the first backtest, the same InOutBars SAR process is used on *EoP* basis (cf. Figure 12(left)). Next, this stop is complemented with the standard Version of StopInOutBars (cf. Table 3) on an intra-period basis. Furthermore, we restrict InOutBars SAR to only generating entry signals

SAR Backtests.	Entry:	InOutBars Vers 2 on EoP basis				Parabolic SAR EoP	MACD SAR EoP	
	Stops:	same as exit EoP	Standard Intra	PerHighLow (10 per) EoP	Parabolic Intra	Parabolic EoP	same as exit	
total net profit:		76.441,44	53.490,16	71.911,47	67.340,59	61.431,59	51.111,56	36.161,47
total # of trades:		2.779	2.779	2.779	2779	2.779	2.593	2.328
winning trades:		1.020	991	1.019	1051	1.062	1.024	856
losing trades:		1.759	1.788	1.760	1728	1.717	1.569	1.472
percent profitable: p		36,70%	35,66%	36,67%	37,82%	38,22%	39,49%	36,77%
profit factor:		1,16	1,13	1,16	1,16	1,14	1,10	1,08
avg win/avg loss:		2,00	2,04	2,00	1,91	1,84	1,69	1,85
Expectation (Avg trade, win & loss): $\hat{\mu}$		27,51	19,25	25,88	24,23	22,11	19,71	15,53
percent in the market:		35,17%	29,14%	30,39%	22,31%	23,90%	34,74%	33,05%
gross profit:		550.970,50	466.560,13	533.880,50	478.550,09	497.260,66	543.260,63	500.180,59
gross loss:		474.529,06	413.069,97	461.969,03	411.209,50	435.829,06	492.149,06	464.019,13
largest winning trade:		7.640,00	7.540,00	7.640,00	4.280,00	4.050,00	4.670,00	4.750,00
"-" in percent:		9,99%	14,10%	10,62%	6,36%	6,59%	9,14%	13,14%
avg winning trade: $\hat{\mu}_{win}$		540,17	470,80	523,93	455,33	468,23	530,53	584,32
avg # bars in winners:		20,97	17,26	17,73	12,01	12,87	18,70	21,80
largest losing trade:		6.930,00	6.810,00	6.930,00	1.690,00	3.760,00	2.140,00	6.660,00
avg losing trade: $\hat{\mu}_{loss}$		269,77	231,02	262,48	237,97	253,83	313,67	315,23
avg # bars in losers:		7,45	6,41	6,67	5,36	5,69	9,51	9,34
max consecutive winners:		9	9	9	9	9	6	7
max consecutive losers:		14	16	14	14	13	13	12
Std.Dev. all trades: $\hat{\sigma}$		628,52	545,95	610,85	517,28	540,58	614,37	661,11
Std.Dev. winning trades: $\hat{\sigma}_{win}$		702,61	621,02	685,10	571,84	580,63	626,95	672,79
Std.Dev. losing trades: $\hat{\sigma}_{loss}$		311,74	271,95	301,27	222,96	255,49	293,04	361,32
max drawdown:		20.650,00	18.010,15	15.880,00	13.250,03	12.100,18	21.179,46	24.540,27
Commission paid:		27.790,00	27.790,00	27.790,00	27.790,00	27.790,00	25.930,00	23.280,00
Performance/Drawdown:		3,70	2,97	4,53	5,08	5,08	2,41	1,47
evaluation start:		Fri 06.07.07,	00:00 a.m					
evaluation stop:		Thu 01.04.10,	03:50 p.m					

Table 7: InOutBars SAR Vers 2 as entry with various stops; exit and entry for Parabolic SAR and MACD

and use PerHighLow (10 periods) and the Parabolic SAR as stops on both intra-period and EoP basis. The next test uses the Parabolic SAR as system to generate both entry and exit signals (see Figure 12 (right)). The last test is similar but applies solely the MACD as entry and exit.



Figure 12: Equity curve for entry and exit: only InOutBars SAR Vers 2 (left) and only Parabolic SAR EoP (right)

At first glance these methods seem to do well compared to the results of Subsections 4.1 and 4.2. Note, however, that all profit factors fall extremely short compared to the setups of the two subsections before. The comparable net profit can only be archived with about five times as many trades.

4.4 Confidence Intervals

In this section, we apply the central limit theorem. To do so, we have to assume the following:

Assumption 4.1 *Assume that each of our backtested strategies are realizations of stochastic independent identically distributed random variables $X_j: (\Omega, \mathcal{A}) \rightarrow (\mathbb{R}, \mathcal{B})$ on a probability space (Ω, \mathcal{A}, P) with expectation value $\mathbb{E}(X_j) = \mu$ and variance $\text{Var}(X_j) = \sigma^2$ for $j \in \mathbb{N}$.*

Of course, we do not know μ and σ exactly but $\hat{\mu}$ and $\hat{\sigma}$ should be good estimates of μ and σ , respectively. Looking at the sum random variable $S_k: (\Omega, \mathcal{A}) \rightarrow (\mathbb{R}, \mathcal{B})$,

$$S_k(\omega) := \sum_{j=1}^k X_j(\omega) \quad (\text{total net profit after } k \text{ trades}),$$

and its standardized form

$$S_k^* = \frac{S_k - k\mu}{\sqrt{k}\sigma},$$

by virtue of the central limit theorem (cf. [1] §12 and §28, or [3] Section 11.7),

$$\lim_{k \rightarrow \infty} P\left(\{S_k^* \leq t\}\right) = \lim_{k \rightarrow \infty} P\left(\left\{\frac{S_k - k\mu}{\sqrt{k}\sigma} \leq t\right\}\right) = \Phi(t) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^t e^{-y^2/2} dy$$

holds for all $t \in \mathbb{R}$, where Φ is the distribution function of the unit normal distribution. A deduction of this theorem is that for sufficiently large $k \in \mathbb{N}$ we get approximately

$$P\left(\left\{|S_k - k\mu| \leq \sigma\sqrt{k}t\right\}\right) = P\left(\left\{|S_k^*| \leq t\right\}\right) \approx \Phi(t) - \Phi(-t).$$

For instance, if $t = 1$, one obtains that the total net profit S_k after k realization lies with a probability of 68% ($\Phi(1) - \Phi(-1) \approx 0.68$) within the confidence interval

$$\left[k\mu - \sigma\sqrt{k}, k\mu + \sigma\sqrt{k} \right] \approx \left[k\hat{\mu} - \hat{\sigma}\sqrt{k}, k\hat{\mu} + \hat{\sigma}\sqrt{k} \right] .$$

Applying the same technique for $t = 2$ we obtain confidence intervals $\left[k\mu - 2\sigma\sqrt{k}, k\mu + 2\sigma\sqrt{k} \right]$ that are realized with a probability of 95% ($\Phi(2) - \Phi(-2) \approx 0.95$).

If we are only interested, whether the total net profit after k realizations is positive, we observe that

$$\lim_{k \rightarrow \infty} P\left(\left\{S_k > k\mu + t\sqrt{k}\sigma\right\}\right) = 1 - \Phi(t) ,$$

i.e. for k sufficiently large

$$P\left(\left\{S_k > k\mu + t\sqrt{k}\sigma\right\}\right) \approx 1 - \Phi(t)$$

or, with $t_k^* := -\frac{\hat{\mu}}{\hat{\sigma}}\sqrt{k} \approx -\frac{\mu}{\sigma}\sqrt{k}$,

$$P\left(\left\{S_k > 0\right\}\right) \approx 1 - \Phi(t_k^*) = \Phi(-t_k^*) .$$

Table 8 gives the respective confidence intervals for the total net profit and the probability to get a positive net profit after $k = 100$ trades for all backtests from the long setup according to Subsection 4.1.

$k = 100$	confidence interval after k trades					probability for positive total net profit after k trades $\Phi(-t_k^*)$	t_k^* incl. slippage 1tick/halfturn	probability for positive total net profit after k trades incl. slippage 1tick/halfturn
	total net profit $(k\hat{\mu} \pm t\sqrt{k}\hat{\sigma})$		68% $t=1$	95% $t=2$	t_k^*			
InOutBars Vers 1	14.489,00	" +/- "	8.334,10	16.668,20	-1,74	95,9%	-1,50	93,3%
InOutBars Vers 2	14.865,00	" +/- "	8.449,20	16.898,40	-1,76	96,1%	-1,52	93,6%
InOutBars Vers 3	18.551,00	" +/- "	8.965,50	17.931,00	-2,07	98,1%	-1,85	96,8%
InOutBars Vers 4	17.621,00	" +/- "	9.061,30	18.122,60	-1,94	97,4%	-1,72	95,8%
TrailStop 60 Cents	21.768,00	" +/- "	9.863,20	19.726,40	-2,21	98,6%	-2,00	97,7%
TrailStop 40 Cents	14.359,00	" +/- "	7.653,50	15.307,00	-1,88	97,0%	-1,61	94,7%
PerHighLow EoP	19.864,00	" +/- "	11.337,60	22.675,20	-1,75	96,0%	-1,58	94,2%
Parabolic EoP	11.211,00	" +/- "	8.040,90	16.081,80	-1,39	91,8%	-1,15	87,4%
Voigt Stop Intra	14.448,00	" +/- "	8.042,90	16.085,80	-1,80	96,4%	-1,55	93,9%
Voigt Stop EoP	16.811,00	" +/- "	9.900,60	19.801,20	-1,70	95,5%	-1,50	93,3%
Standard Intra	10.324,00	" +/- "	7.447,50	14.895,00	-1,39	91,7%	-1,12	86,8%
Standard EoP	15.128,00	" +/- "	8.932,40	17.864,80	-1,69	95,5%	-1,47	92,9%
Original Intra	10.375,00	" +/- "	7.690,30	15.380,60	-1,35	91,1%	-1,09	86,2%
Original EoP	14.459,00	" +/- "	8.938,00	17.876,00	-1,62	94,7%	-1,39	91,8%

Table 8: Long setup trades of Tables 2 and 4: confidence intervals and probability for positive total net profit

If we use slippage of one tick/halfturn, the average trade $\hat{\mu}$ will decrease by 20\$ for all tested systems since we report prices for one contract with 1000 barrels. Therefore, to get the respective confidence intervals after $k = 100$ trades including slippage, we only have to reduce the second column in Table 8 by 2000\$. The last two columns adjust the probability for a positive total net profit when slippage of one tick/halfturn is included. A similar approach for our short setup from Subsection 4.2 is given in Table 9.

$k = 100$	confidence interval after k trades					probability for positive total net profit after k trades $\Phi(-t_k^*)$	t_k^* incl. slippage 1tick/halfturn	probability for positive total net profit after k trades incl. slippage 1tick/halfturn
	total net profit $(k\hat{\mu} \pm t\sqrt{k}\hat{\sigma})$		68% t=1	95% t=2	t_k^*			
InOutBars Vers 1	10.609,00	" +/- "	7.008,10	14.016,20	-1,51	93,5%	-1,23	89,0%
InOutBars Vers 2	13.118,00	" +/- "	7.795,30	15.590,60	-1,68	95,4%	-1,43	92,3%
InOutBars Vers 3	12.182,00	" +/- "	7.927,20	15.854,40	-1,54	93,8%	-1,28	90,1%
InOutBars Vers 4	10.553,00	" +/- "	7.865,70	15.731,40	-1,34	91,0%	-1,09	86,2%
TrailStop 60 Cents	10.259,00	" +/- "	8.481,10	16.962,20	-1,21	88,7%	-0,97	83,5%
TrailStop 80 Cents	16.340,00	" +/- "	10.677,40	21.354,80	-1,53	93,7%	-1,34	91,0%
PerHighLow EoP	20.150,00	" +/- "	11.642,80	23.285,60	-1,73	95,8%	-1,56	94,0%
Parabolic EoP	9.284,00	" +/- "	8.167,20	16.334,40	-1,14	87,2%	-0,89	81,4%
Voigt Stop Intra	9.438,00	" +/- "	7.329,70	14.659,40	-1,29	90,1%	-1,01	84,5%
Voigt Stop EoP	15.143,00	" +/- "	9.157,50	18.315,00	-1,65	95,1%	-1,44	92,4%
Standard Intra	12.718,00	" +/- "	7.552,40	15.104,80	-1,68	95,4%	-1,42	92,2%
Standard EoP	14.096,00	" +/- "	8.218,80	16.437,60	-1,72	95,7%	-1,47	92,9%
Original Intra	11.178,00	" +/- "	7.343,50	14.687,00	-1,52	93,6%	-1,25	89,4%
Original EoP	14.570,00	" +/- "	8.281,80	16.563,60	-1,76	96,1%	-1,52	93,5%

Table 9: Short setup trades of Tables 5 and 6: confidence intervals and probability for positive total net profit

Finally in Table 10 the confidence intervals and probabilities for positive total net profit are calculated for the SAR entry backtests of Subsection 4.3. As already suspected, the systems of Table 10 cannot be recommended. Looking at the probability for a positive total net profit this is close to throwing a coin.

5 Conclusion

We introduced the indicator InOutBars SAR based on the idea of outbars and corresponding inbars. This indicator was complemented by an intra-period stop process StopInOutBars. The statistical tests reveal that InOutBars SAR can be successfully used as *EoP* stop process to follow big movements which are initiated either by *instant volatility breakout* (long setup) or *breakouts with short stops* (short setup).

In both long and short setups, this process can compete well with other standard stop processes such as PerHighLow, Parabolic SAR or TrailStop. However, in all cases (long and short setup) the

$k = 100$ entry first five tester InOutBars SAR Vers 2	confidence interval after k trades					probability for positive total net profit	t_k^* incl. slippage 1tick/halfturn	probability for positive total net profit after k trades
	total net profit ($k\hat{\mu} \pm t\sqrt{k}\hat{\sigma}$)		68% t=1	95% t=2	t_k^*	after k trades $\Phi(-t_k^*)$		incl. slippage 1tick/halfturn
exit:								
InOutBars SAR (EoP)	2.751,00	" +/- "	6.285,20	12.570,40	-0,44	66,9%	-0,12	54,8%
Standard Intra	1.925,00	" +/- "	5.459,50	10.919,00	-0,35	63,8%	0,01	49,5%
PerHighLow (EoP)	2.588,00	" +/- "	6.108,50	12.217,00	-0,42	66,4%	-0,10	53,8%
Parabolic Intra	2.423,00	" +/- "	5.172,80	10.345,60	-0,47	68,0%	-0,08	53,3%
Parabolic EoP	2.211,00	" +/- "	5.405,80	10.811,60	-0,41	65,9%	-0,04	51,6%
entry and exit:								
Parabolic SAR EoP	1.971,00	" +/- "	6.143,70	12.287,40	-0,32	62,6%	0,00	49,8%
MACD SAR EoP	1.553,00	" +/- "	6.611,10	13.222,20	-0,23	59,3%	0,07	47,3%

Table 10: SAR backtests: confidence intervals and probability for positive total net profit

intra-period stops fall short to corresponding *EoP* stops. This is true for StopInOutBars but also for the other tested standard stop concepts. Nevertheless, in order to limit the maximal risk to the market, such intra-period stops may be used on a profitable basis in particular for the short setup. At least for the long setup, this additional safety net clearly has a price.

The usage of InOutBars SAR as an independent trading system (long and short signals) can not be recommended.

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