

Bollinger Band Breakout System



Volatility breakout systems were already developed in the 1970ies and have stayed popular until today. During the commodities boom in the '70ies they made fortunes, but in the following decades they lost, in part, their attraction since the impressive volatility that unsettled markets in the '70ies disappeared. The basis of these systems is the assumption that markets go through alternating phases of smaller and bigger activity. This means that big profitable movements usually take place after the market has calmed down.



One possibility to construct such a volatility breakout system is to use Bollinger bands, a today widespread technical tool. Even if it is commonly known under the name of this famous US trader, it is nothing different than the practical application of the Gaussian distribution to the markets. This article shows how the results of a trading system based on Bollinger bands change from intraday data, e.g. 60 minutes, to daily data. While the system, which is based on daily data, shows impressive results on almost every important futures market, it loses results and strength when the same trading logic is applied to intraday data. The bad result of the intraday system cannot be changed by adding any types of filters like ADX, moving average etc. In contrast, the daily Bollinger band system stays robust during parameter changes in a wide range. It is important to mention that from this behaviour you cannot conclude a general rule. You cannot state that a system that works on an intraday basis does not perform in overnight trading and vice versa. Intraday volatility is not overnight volatility, and the logic of a system can be more prone to overnight trading than to intraday trading. Noise in prices is always difficult, not only to measure, but even to define. Every system has its own logic and you cannot assume any kind of conclusion, even if a system can perform both on an intraday and daily basis. Our goal is to show that every system you build should always be tested accurately, both on a daily and intraday framework since nobody can tell you before if it is more suitable to intraday or overnight trading.

Trading-Logic

The well-known Bollinger bands are used to construct a long-term breakout system. The "standard" Bollinger-indicator is constructed by calculating a moving average of an appropriate length and then adding (higher band) and subtracting (lower band) a number of standard deviations for the same time period.

Usually the Bollinger bands are charted together with the price (Figure 1).

The trading logic is simple

Long Entry: If the price crosses above the higher Bollinger band. Enter the market intraday with a buy stop:

Enter Long: next bar at HigherBand stop;

Short Entry: The short entry is symmetrical to the long entry, enter intraday if the price crosses below the lower Bollinger band.

Enter Short: next bar at LowerBand stop;

Exit: Exit if the price crosses the moving average between the Bollinger bands:

Exit: next bar at Average(Close,60) stop;

The exact position of the higher and the lower Bollinger band is determined by taking the simple moving average and adding (higher band) or subtracting (lower band) the following, volatility dependant amount: $\text{Distance} * \text{Standard-Deviation}$. The volatility dependant components is located within the standard deviation, whereas the distance is a fixed parameter which can be varied. We chose it as one of the two input parameters of the system code. Let us have a look at the complete Easy Language code for the Bollinger band system:

Inputs: **Length**(60), **Distance**(2);
 Bars: HigherBand(0),LowerBand(0);

HigherBand = Average(Close, **Length**) + **Distance** * StdDev(Close, **Length**);
 LowerBand = Average(Close, **Length**) - **Distance** * StdDev(Close, **Length**);

Buy next bar at HigherBand stop;
 Sell next bar at LowerBand stop;

ExitLong next bar at Average(Close, **Length**) stop;
 ExitShort next bar at Average(Close, **Length**) stop;

As you can see from the Easy language code the system has two input parameters, which are bold typed. One represents the length of the moving average, the other determines the distance (or width) of how far away from this moving average the Bollinger Bands are placed. Their default values are set to a length of 60 and distance of 2. By changing these parameters you can adjust the trade frequency. The smaller you set the length for the moving average and the smaller you choose the distance of the Bollinger Bands the faster the system will react to market changes and the more signals you will get. Despite the possibility to adjust the system code to your personal needs,

Bollinger band have further advantages for building mechanical trading systems. Due to their volatility based component they can easily adapt to different market conditions. Additionally they provide a natural exit point by using the moving average between the Bollinger bands.

Let us analyse the behaviour of the Bollinger bands with the help of the examples shown in Figure 1. The first third of the graph (August-October 2004) shows a phase of lower market activity. The volatility drops and the Bollinger bands become narrower. During this period of lower volatility the market often trends sideways without any direction. Many market participants are unsure about the further development and stay on the sidelines.

Such phases of decreasing interest of market participants form the base of succeeding considerable movements. The longer the indecisive phase is, the stronger the subsequent breakout (see Figure 1, mid October till December 2004). After the breakout the Bollinger bands widen and follow the trending price very quickly. From Figure 1 you can calculate the profit of the trade which uses this impulsive long breakout. It brings 6 cents (=7,500 US-Dollar in the Euro-future) although some of the gains have been given away. Shortly after the long exit a short signal was triggered (February 2005), which turned out to be a false breakout and was soon exited by the moving average stop.

In the next section the strategy will be applied to a portfolio of seven different markets with the default values (length=60, distance=2). We will test our trading logic with the same parameters, without any optimisation, on 60 minutes intraday data and on daily market data on the same seven markets. It will be interesting to see how the results change between the two different time scales.

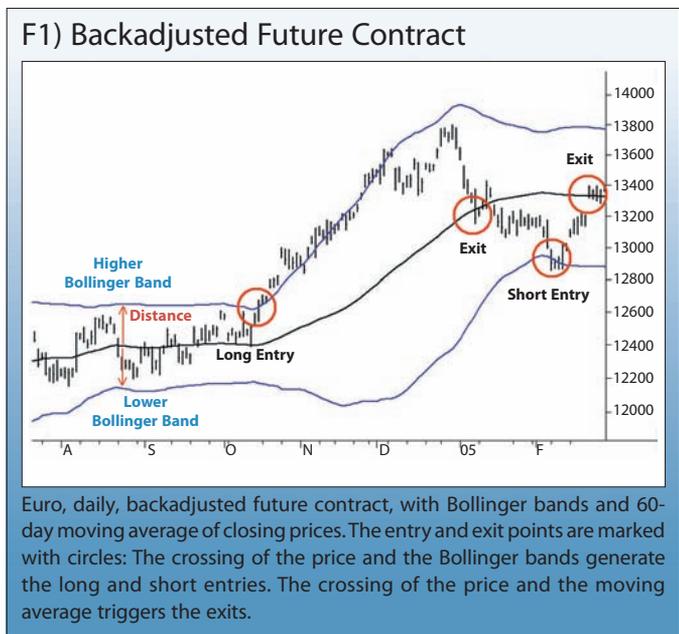
Application of the Strategy

Now that we have built and understood the system's logic we can test it under different market conditions. The strategy will be applied to intraday 60-min and daily data of the same following seven markets from three different market groups:

- 3 Stock-Index-Futures: Nasdaq-Mini, EuroStoxx50 and Swiss Market Index
- 2 Bond-Index-Futures: Bund, US-T-Note (10 year)
- 2 Currency-Futures: Euro and Swiss-Franc

All futures data are point-based back adjusted. This standard method of data adjustment insures a continuous data series without any artificial gaps, which usually occur at the roll to a new contract month. Daily data was taken from mid 1994 until mid 2005. The data for the intraday tests covered the period from January 1997 until August 2004. Data source for the intraday data was TICK DATA (tickdata.com) and for the of end-of-day data CSI (csidata.com).

For all the performed tests exactly the same parameters (default) were taken in order to avoid the effect of curve fitting. All results are based on a one contract per market basis. Any considerations in terms of money and risk management are beyond the scope of this article. Furthermore it is important to mention that all results in the figures and tables are presented without subtraction of slippage and commissions. This simplifies the back-testing procedure and the visualisation of results. However, in the analysis of the system's statistics



we take the slippage and commissions into account in order to compare results at conditions as close to the real market as possible.

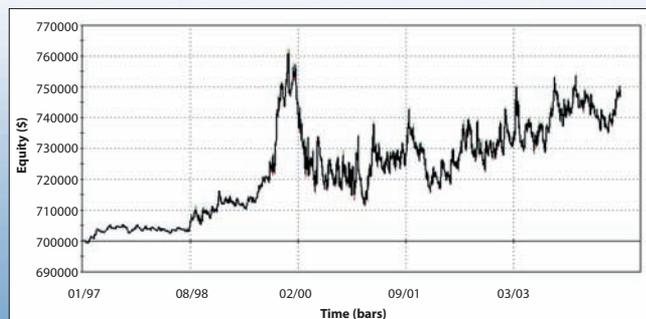
Results, Based on 60-min Intraday Data

Let's start with the application of the strategy to intraday data. We will apply the Bollinger band strategy to the seven markets with exactly the same parameters (default) in order to minimise curve fitting. The equity lines of the seven markets were added to a portfolio, which results in a combined equity line (Figure 2).

Although you have an overall positive return the equity line looks untradable. There is a big equity peak at the end of the year 1999, which is followed by a sharp drawdown in which nearly all profits were given away. If you then have a closer look at the system figures and ratios (table 1) you will get the confirmation that the result is not sufficient for trading. The profit factor of 1.09 is only slightly positive. Although there is a high ratio of average winning/average losing trade, you can only reach an average profit per trade of 32 \$. If you subtract now slippage and commissions (typically about 50-150\$, depending on the market) this result becomes negative.

In addition to the insufficient performance of the base system there are further negative facts: If you try to add indicator-based filters, e.g. a trend or volatility filter, or put in additional stops, this does not improve the overall performance significantly. For example, if you allow long signals only if the current close is above its 200-day moving average (analogue for the short side: restrict short signals to situations when the current close is below its 200-day moving average) you can only improve the average trade to about 80\$ per trade without slippage and commissions, which is still useless in practical trading. The system was further tested on 5-minutes and 15-minutes data. The results on this data showed a higher trade frequency with an even smaller average profit per trade.

F2) 60 minute intraday data



The figure shows the combined equity curve of the Bollinger Band-System for the portfolio of 7 Markets, 01/1997-08/2004, applied to 60-min intraday data. The figure shows the added results of all trades on these markets without slippage and commissions. The detailed equity line offers greater insight into trading performance than a general equity curve graph. It displays net profit on a bar-by-bar basis revealing equity run-ups and draw-downs.

T1) 60 Minute Intraday Data

System Analysis		Time Analysis (Days)	
Net Profit	\$45,726.77	Percent in the market	79.31%
Gross Profit	\$547,597.27	Longest flat period	11.67
Gross Loss	(\$501,870.50)		
		Avg. time in trades	6.06
Percent profitable	35.08%	Avg. time between trades	0.40
Ratio avg. win/avg. loss	2.02		
		Avg. time in winning trades	11.28
Profit factor	1.09	Avg. time between winning trades	1.42
Maximum Drawdown	(\$8,758.00)	Avg. time in losing trades	3.24
Average Drawdown	(\$517.08)	Avg. time between losing trades	1.46
Number of total trades	1,414		
Average trade	\$32.34	Avg. time between peaks (days)	57.06

The table shows the main figures of the Bollinger Band-System for the portfolio of 7 Markets, 01/1997-08/2004, applied to 60-min intraday data. The table shows the added results of all trades on these markets without slippage and commissions.

How to Improve Intraday Results

One reason for the failure on intraday data is the fact that Bollinger bands are derived from a moving average. It is well known that moving averages cannot react fast enough to some special market situations, e.g. to gaps, which occur especially overnight. One possibility to overcome this problem would be to introduce adaptive moving averages for shorter term systems e.g. Perry Kaufmans adaptive moving average. Another possible solution to overcome the problem of the overnight gaps could be the usage of a "time filter". If you restrict the allowed entry times to certain time spans in which you trade on an intraday basis, Bollinger band results could be improved. The allowed trading time would have to be chosen individually for each market, e.g. for the EUREX Bund futures something like from 9:00 a.m. up to 12:00 a.m. and from 2:00 p.m. up to 6:00 p.m.

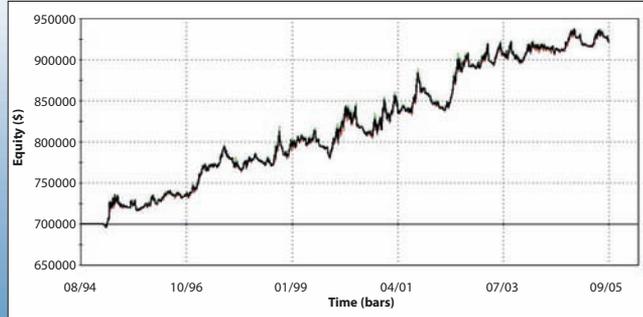
A second reason for the changing performance of our breakout system on intraday data is the market volatility. If you look on the detailed equity curve (Figure 2) you can see that the system had its best performance in the years 1998 and 1999. This was the time of the stock market bubble with the highest volatility in most financial markets. In an environment of higher volatility intraday systems perform better. That is why the currencies, which had a higher volatility, kept a much better performance in the last years for short term trading systems. The vanishing volatility in the major stock and bond indices over the last years provided a more difficult environment for short-term strategies.

Results, Based on Daily Data

The Bollinger band strategy will now be applied to exactly the same 7 markets with exactly the same parameters (default), but to data of a different time scale. Instead of 60-minute intraday data we'll now use end-of-day daily futures data for our tests.

The equity line (Figure 3) looks like a good starting point for a viable trading system. Even within the detailed equity curve, which shows net profit on a bar-by-bar basis, the equity line is quite smooth and steady. Every minor drawdown is soon recovered. The equity curve also rises within the last three years, which have been generally difficult for trend-following strategies. It's important to mention here that the same parameters for all markets have been taken. No optimisation or

F3) Equity Line



The figure shows the combined equity line of the Bollinger band system for the portfolio of seven markets, 08/1994-09/2005, for daily data. The figure shows the added net profit on a bar-by-bar basis of all trades on these markets without slippage and commissions.

adaptation of the system to the different markets has been performed.

The good result is underlined by the figures of the 7-market portfolio:

The system possesses a typical characteristic of a good trend-following method: a low percentage of profitable trades (42%) but a high ratio of average win/average loss of 2.69. This means that with this system you have many smaller losses and fewer bigger winners which generate the high profit factor of 1.96. The maximum drawdown of 8,120\$ is fantastic low compared with the generated net profit of more than \$220,000. If we subtract 100\$ slippage and commissions per trade we have to subtract $261 \times 100\$ = 26,100\$$ from this net profit (because the total number of trades was 261). This is only slightly more than 10% of the net profit. The result has not changed significantly by this as the system based on daily data produces only few trades and stays long in the market (in average 59 days per trade). Further impressive figures are the longest time between new equity highs (Avg. time between peaks) of 120 days and a low average drawdown of 1424\$. You can also see in the figures that the system lets the profit run and keeps the losses short. Winning trades last in average over 100 days, whereas losing trades only last 27 days.

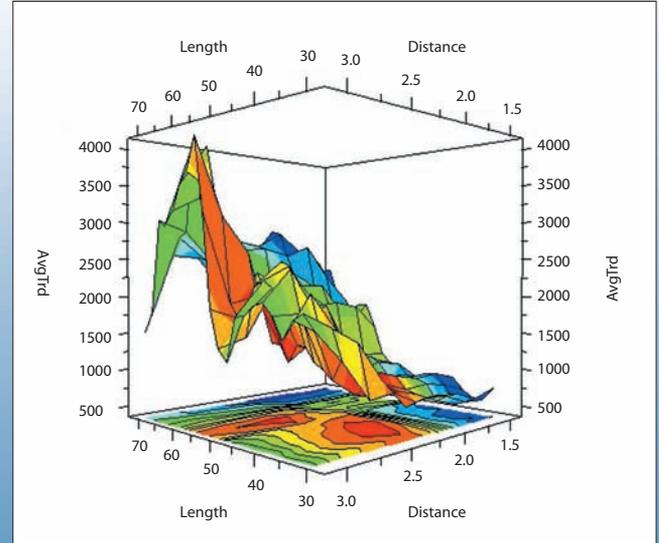
An average profit per trade of 846\$ (or about 740\$ after subtracting 100\$ slippage and commissions) on a single contract basis is a really high value, especially when it is compared to the poor 32\$ profit per trade which was produced by the application of the system to 60 minutes intraday data.

Robustness Tests

To increase your confidence into a system it is good to perform further stability tests before using it in real trading. This can be done by varying the input parameters. In our case the variables of the system are the length of the moving average and distance of the Bollinger bands away from this moving average.

If you plot the average trade in US-Dollar as a function of these two input parameters (Length,

F4) Diagram for the Average Profit per Trade



The figure shows the average profit per trade in US-Dollar as a function of the two system parameters Bollinger band length and distance of the Bollinger bands (Default values: Bollinger band length =60; band distance=2). The area diagram represents the test results for the Euro-Future, daily data, 08/1994-09/2005, without subtraction of slippage and commissions.

Distance) you can get, for each of the seven tested markets, a graph similar to the one shown in Figure 4.

Figure 4 shows the result of 189 system tests for the Euro (CME, daily). The Bollinger band length was varied from 30 to 70 in steps of 2, the band distance from 1.5 to 3 in steps of 0.2. Whereas such a test had been a challenge some years ago, it can be performed in one minute nowadays with a fast enough PC and the right software.

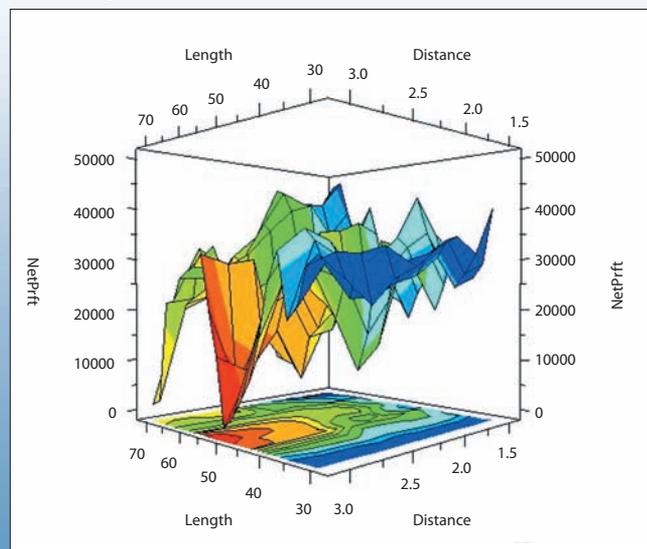
As you can see the average trade stays positive in the area above 500 Dollar for all parameter combinations. An interesting observation of the diagram is that the average trade increases with the length of the Bollinger bands and the distance of the bands. This means that

T2) End-of-Day Data

System Analysis		Time Analysis (Days)	
Net Profit	\$220,943.00	Percent in the market	82.28%
Gross Profit	\$451,455.50	Longest flat period	77.00
Gross Loss	(\$230,512.50)		
		Avg. time in trades	59.53
Percent profitable	42.15%	Avg. time between trades	2.14
Ratio avg. win/avg. loss	2.69		
		Avg. time in winning trades	103.71
Profit factor	1.96	Avg. time between winning trades	2.88
Maximum Drawdown	(\$8,120.00)	Avg. time in losing trades	27.34
Average Drawdown	(\$1,424.51)	Avg. time between losing trades	10.70
Number of total trades	261		
Average trade	\$846.52	Avg. time between peaks (days)	120.10

The table shows the main figures of the Bollinger Band-System for the portfolio of 7 Markets, 08/1994-09/2005, applied to daily data. The table shows the added results of all trades on these markets without slippage and commissions.

F5) Diagram for the Total Net Profit



The figure shows the total net profit in US-Dollar as a function of the two system parameters Bollinger band length and distance of the bollinger bands (Default values: Bollinger band length =60; band distance=2). The area diagram represents the test results for the Euro-Future, daily, 08/1994-09/2005, without subtraction of slippage and commissions.

the higher the lookback period of the Bollinger bands is chosen (with a higher value for the parameter length) and the further away from the actual closing price the bands are taken (with a higher value for the parameter distance) the higher is the average profit per trade. This shows that breakouts out of the Bollinger bands become more reliable with bigger width (distance) of the bands and a longer lookback period. On the other hand the total net profit does not have its maximum at very big Bollinger band length and distances. It shows, on the contrary, even if the distance-parameter is set very high (see left side of Figure 5).

At the most parameter combinations the total net profit stays however quite constant (Figure 5). You can conclude from this that the lower profits are compensated by a higher trade frequency at smaller band distances and lengths. Our default parameters (Bollinger band length =60; band distance=2) were chosen somewhere in the middle of the stable plateau and kept the same for all tested markets. Of course it is possible to improve the results of this system by choosing optimised parameters for each market. Keep in mind however that such a step is only curve-fitting and test results will become less indicative for future profits. We recommend sticking to the default parameters for all markets. With these parameters we received good results and more important achieved a great robustness of our system under different market conditions.

Conclusion

In this article a mechanical Bollinger band breakout system was presented. Our focus was not the optimisation of the trading logic for a particular market environment.

Instead the robustness of the strategy was considered to be the most important. Therefore we applied the trading system with

unchanged parameters to a portfolio of seven markets within two different time scales. Like this the results of the backtests are a better indication for the future and not only an adaptation to special conditions of the past.

While the system showed good results on daily market data, the change of time scale to intraday data lead to a significant drop of performance. The gained result is however not useless but gives a deeper insight into the character of the presented system. It helps to get a better feeling how to apply it in real trading.

The performed tests on end-of-day market data showed impressive results on a portfolio of seven markets. Within a test period of 10 years, from 1995-2005, the system obtained steady profits of about 20,000 US-Dollars per year with a small maximum draw-down of 8,000 US-Dollars. Numerous stability tests were performed and showed positive results during variation of the system's two input parameters in a wide range. Together with the knowledge of the robustness of the strategy these tests help further to increase your confidence into the system. With the Bollinger band breakout system you should have a good tool to make profits in today's markets.

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