

# An Empirical Comparison of Moving Average Envelopes and Bollinger Bands

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## Abstract

This paper endeavors to compare the profitability of Moving Average Envelopes and Bollinger Bands. Despite the fact that Bollinger Bands can capture sudden price fluctuations which Moving Average Envelopes cannot, our study reveals that Bollinger Bands do not outperform the Moving Average Envelopes.

**Keywords:** Moving Average Envelopes; Bollinger Bands

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## 1 Introduction

There are many theories explaining price movements in stock markets. For example, the Orthodox Theory which suggests that the primitive source of

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stock price movement is the anticipation of corporate earnings changes, and the Confidence Theory which states that the basic rationale of stock price movement is the fluctuations of investor's confidence in the future stock prices, earnings and dividends. A more popular theory is the Efficient Market Hypothesis (EMH), which states that trading prices of assets in organized markets reflect all available information, and prices change only because of news that is not known beforehand. The weak form EMH suggests that current prices of assets at least reflect their own history. Therefore, if the market is weakly efficient, studying the price history alone will not be able to make profits. However, there are studies supporting technical strategies (Treyner and Ferguson, 1985; Brock, Lakonishok and LeBaron, 1992). The effectiveness of making profits using technical trading rules is an evidence of market information inefficiency (Taylor, 1997).

The Simple Moving Average rule is the most frequently studied trading rule in the literature. However, when the market does not have a clear trend, or when prices fluctuate a lot around a trend, it is more appropriate to use the channels to capture the short run fluctuations. Two of these channels which are increasingly popular are the Moving Average Envelopes and the Bollinger Bands. Few, if any, empirical studies have been done in exploring their profitability. This paper endeavors to compare the performance of these two channels by using the stock market indices of the G7 and the Four Asian Tigers.

## 2 Trading Rules and Data

The Moving Average Envelopes and the Bollinger Bands are channels that based on the Simple Moving Average. The N-day Simple Moving Average at time  $t$  is the mean of the prices in the past  $N$  days, i.e.,

$$SMA_N(t) = \frac{\sum_{i=t-N+1}^t P(i)}{N}. \quad (1)$$

The N-day Moving Average Envelopes at time  $t$  is defined as:

$$MAE_N^{k\%}(t) = SMA_N(t) \times (1 \pm k\%), \quad (2)$$

where  $k$  is a constant.

The width of the Moving Average Envelopes depends on  $k$  and the stock prices. The Moving Average Envelopes will contract when  $k$  or the stock prices fall.

The N-day Bollinger Bands with  $k$  standard deviations at time  $t$  is defined as:

$$BB_N^k(t) = SMA_N(t) \pm k \times \sqrt{\frac{\sum_{i=t-N+1}^t [P(i) - SMA_N(i)]^2}{N}}. \quad (3)$$

An advantage of the Bollinger Bands over the Moving Average Envelopes is that it takes the price volatility into consideration. Unlike the Moving Average Envelopes, the width of the Bollinger Bands depends on the fluctuation of the prices around the mean, rather than the level of the moving average. When the volatility increases in such a way that the moving average remains unchanged, the Bollinger Bands will expand to capture the price fluctuations, while the Moving Average Envelopes will not. If the stock prices follow a normal distribution, the Bollinger Bands with 2 standard deviations will capture about 95% of the price movements.

The region above the upper bound of the Moving Average Envelopes or the Bollinger Bands is considered as overbought area, while the region below the lower bound is considered as oversold. In general, when a stock is considered as overbought, investors should sell it because the price of the stock is expected to fall, and vice versa. However, as it is hard to predict how long a stock will stay in overbought or oversold region, it is better not to take any position until the stock moves away from those regions.

For the Moving Average Envelopes, the trading rules are defined as follows:

$$\begin{aligned} \text{Buy:} \quad & P_N(t-1) < MAE_N^{low}(t-1) \text{ and } P_N(t) > MAE_N^{low}(t). \\ \text{Sell:} \quad & P_N(t-1) > MAE_N^{up}(t-1) \text{ and } P_N(t) < MAE_N^{up}(t). \end{aligned}$$

For the Bollinger Bands, the trading rules are:

$$\begin{aligned} \text{Buy:} \quad & P_N(t-1) < BB_N^{low}(t-1) \text{ and } P_N(t) > BB_N^{low}(t). \\ \text{Sell:} \quad & P_N(t-1) > BB_N^{up}(t-1) \text{ and } P_N(t) < BB_N^{up}(t). \end{aligned}$$

Therefore, a buy signal will be generated when the price crosses the lower bound from below. Similarly, a sell signal will be generated when the price penetrates the upper bound from above.

In this paper, the 10-day, 20-day, 50-day and 250-day Moving Average Envelopes of 3% and 5% and Bollinger Bands of 2 standard deviations are studied. We assume that the transaction cost and the stock dividend are negligible. We also assume that short selling is not allowed, and transactions cannot be accumulated, i.e., two consecutive buying actions are not allowed.

Since there are about 250 trading days each year, the performance is evaluated in terms of annualized rate of return by the following equation:

$$\text{Annual rate of return} = [(1 + r_1)(1 + r_2)(1 + r_3)\dots(1 + r_m)]^{\frac{250}{T}} - 1, \quad (4)$$

where

$$1 + r_j = \frac{S(j)}{B(j)};$$

$S(j)$  and  $B(j)$  are selling and buying prices respectively in the  $j^{th}$  transaction;

$m$  is the number of transactions;

$T$  is the number of trading days in the sample.

Our data consists of the daily closing stock market indices of G7 and 4 Asian Tigers. The data is extracted from the Data Stream in University Library at the Chinese University of Hong Kong and the details are as follows:

<b>Index</b>	<b>Location</b>	<b>From</b>	<b>To</b>
Dow Jones Industrials	USA	1/1/1985	29/12/2000
Toronto 300	Canada	1/1/1985	29/12/2000
BCI Global	Italy	1/1/1985	29/12/2000
FTSE 100	United Kingdom	1/1/1985	29/12/2000
DAX	Germany	5/9/1989	29/12/2000
Nikkei 225 Stock Avg.	Japan	3/1/1985	29/12/2000
CAC40 Instantaneous	France	16/7/1987	29/12/2000
KOSPI	South Korea	4/1/1985	29/12/2000
Straits Time Index	Singapore	4/1/1985	29/12/2000
Hang Seng Index	Hong Kong	1/1/1985	29/12/2000
TWSE	Taiwan	4/1/1985	29/12/2000

### **3 Results and Conclusion**

Table 1 shows the annual rate of return generated by the trading rules of Moving Average Envelopes and Bollinger Bands. The figures in the brackets are the number of transactions.

**Table 1: Annual Rate of Return for MAE and BB**

Index Names	$MAE_{10}^{3\%}$	$MAE_{10}^{5\%}$	$BB_{10}^2$	$MAE_{20}^{3\%}$	$MAE_{20}^{5\%}$	$BB_{20}^2$
Dow Jones	6% (25)	3% (5)	<b>11%</b> (68)	8% (31)	6% (8)	<b>9%</b> (49)
Toronto 300	2% (15)	<b>5%</b> (4)	1% (51)	0% (26)	5% (7)	2% (34)
BCI Global	<b>4%</b> (47)	-1% (13)	3% (53)	<b>4%</b> (47)	1% (23)	0% (44)
FTSE 100	2% (18)	<b>2%</b> (3)	2% (52)	<b>3%</b> (28)	-1% (7)	3% (41)
DAX	4% (43)	<b>13%</b> (11)	7% (57)	3% (41)	<b>9%</b> (19)	4% (44)
Nikkei 225	<b>0%</b> (44)	-1% (12)	-2% (54)	-2% (39)	<b>-1%</b> (21)	-1% (43)
CAC40	1% (46)	<b>6%</b> (11)	3% (47)	3% (41)	6% (18)	<b>20%</b> (32)
KOSPI	4% (73)	<b>4%</b> (31)	-9% (38)	<b>1%</b> (54)	-2% (31)	-7% (32)
Straits Time	3% (49)	<b>3%</b> (19)	1% (60)	<b>0%</b> (41)	-5% (21)	-1% (46)
Hang Seng	4% (60)	8% (23)	<b>10%</b> (59)	9% (50)	4% (27)	<b>10%</b> (44)
TWSE	<b>-4%</b> (80)	-6% (36)	-6% (49)	6% (58)	<b>10%</b> (35)	-7% (33)

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Index Names	$MAE_{50}^{3\%}$	$MAE_{50}^{5\%}$	$BB_{50}^2$	$MAE_{250}^{3\%}$	$MAE_{250}^{5\%}$	$BB_{250}^2$
Dow Jones	<b>7%</b> (26)	4% (12)	6% (25)	2% (7)	2% (4)	<b>3%</b> (3)
Toronto 300	<b>4%</b> (23)	2% (10)	3% (21)	2% (9)	2% (6)	<b>4%</b> (4)
BCI Global	<b>5%</b> (32)	3% (22)	1% (19)	<b>3%</b> (12)	0% (6)	0% (3)
FTSE 100	<b>5%</b> (22)	4% (15)	2% (18)	5% (13)	<b>7%</b> (9)	5% (4)
DAX	9% (29)	<b>9%</b> (19)	6% (19)	2% (11)	4% (8)	<b>7%</b> (6)
Nikkei 225	<b>1%</b> (29)	-4% (16)	-3% (20)	<b>-1%</b> (7)	-2% (6)	-5% (4)
CAC40	0% (28)	<b>6%</b> (20)	3% (19)	1% (10)	2% (7)	<b>3%</b> (3)
KOSPI	<b>2%</b> (30)	-4% (21)	-4% (18)	<b>-3%</b> (9)	-7% (9)	-5% (4)
Straits Time	-3% (27)	<b>3%</b> (21)	-1% (20)	6% (14)	2% (9)	<b>8%</b> (7)
Hang Seng	5% (32)	4% (18)	<b>7%</b> (19)	3% (12)	4% (9)	<b>8%</b> (5)
TWSE	<b>7%</b> (35)	0% (24)	-5% (17)	<b>-1%</b> (12)	-3% (9)	-4% (4)

For each given  $N$ , we highlight the highest rate of return. For example, when  $N=10$ , the rate of return generated by the Bollinger Bands with 2 standard deviations is the highest when compared to those generated by 3%-MAE and 5%-MAE. If there are more than one highest rate, we highlight the one with the smallest number of transactions. Both trading rules generate a considerable rate of returns for Dow Jones, DAX, CAC and Hang Seng Index. However, for Nikkei 225 and KOSPI, both rules generate a negative rate of return in most cases.

Note that the number of transactions generated by the Moving Average Envelopes rule falls with the value of  $k$ . This is because the larger the value of  $k$ , the more the price fluctuations will be captured by the envelopes and the fewer the trading signals will be observed. Note also that the number of transactions generated by both channel rules falls with  $N$ . In general, when  $N=10$  and 20, the number of transactions for Bollinger Bands and for MAE-3% are close. While for  $N=50$  and 250, the number of transactions for Bollinger Bands is closer to the number of transactions for MAE-5%.

Note from Table 1 that the MAE rule performs better than the BB rule for  $N=10, 20$  and 50, while the BB rule performs better when  $N=250$ . Therefore, we suggest to use the Moving Average Envelopes for short term investment and use Bollinger Bands as a long term investment tool. However, since technical trading rules are usually designed for short term investment purpose, it would be reasonable to conclude that Moving Average Envelopes are better than Bollinger Bands in practice. Therefore, despite the fact that Bollinger Bands can capture sudden price fluctuations that the Moving Average Envelopes cannot, they do not out-perform the Moving Average Envelopes in terms of profitability.

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