

Decision Rules, Candlesticks, and Spreadsheets in Teaching Market Efficiency

Marshall J. Horton and James Files

I. Introduction

This paper shows how students can construct spreadsheets using publicly available data to test market efficiency in the weak sense using historical data. The results produced by this method indicate that the candlestick approach does not help in stock selection. In fact, any trading rule that can be expressed by a series of inequalities can be used with this approach, showing the student first hand that stocks are indeed efficient. The authors hope that investment instructors, who want students to see for themselves that markets tend to be efficient, will find utility in this method in the classroom.

A commonplace in teaching investment theory is the student who knows that he or she can “beat the market.” Heedless of the academic literature on the Efficient Markets Hypothesis (EMH) (Fama 1970; Malkiel 1973), some students may question the numerous studies that have found technical analysis to be of little or no value. The weak form of the EMH, found in every investments textbook, states that investors have already used all past price information in agreeing on the prices that the market currently reports. Therefore, past price information for a stock is of no value in predicting future movements of the stock’s price. But this is a tough sell for students who have dreams of retiring at age thirty after a few years of day-trading.

A lesser known technique for charting, the Japanese method of “Candlestick Charting,” purports to provide signals for an investor to collect pure arbitrage profits from buying and selling stocks. The subject of more than twenty products currently offered at Amazon.com, Candlestick Charting was popularized in this country by Nison (1991). Three leading investments textbooks mention this technique with no evaluation of its effectiveness (Corrado and Jordan 2005, Mayo 2006; Strong 2007). This omission could lull students into believing that candlesticks, because they use more information than just closing prices, may be effective when simpler charting methods are not. In a study using mutual fund data, Caginalp and Laurent (1998) found potential benefits to using simple trading rules based on candlesticks. Marshall, Young, and Rose (2006), concluded that candlestick methods had no informational value for the Dow Jones Industrial Average, affirming the weak form of the efficient markets hypothesis. Horton (2008), extending Caginalp and Laurent’s decision rules and using a larger data set with individual stock price data, rejected the effectiveness of candlestick methods and affirmed that stocks are weakly efficient.

II. The Candlestick Method

The method is simple to apply. It requires the following information for the financial asset: Opening Price, High Price, Low Price, and Closing Price. These four pieces of information can be used to construct a figure called a “candlestick.” The interval between the opening price and closing price is the body of the candlestick, colored white if the close exceeds the opening and colored black if the opening exceeds the close. The distance by which the low

Marshall Horton is Associate Professor of Economics. & Finance at Ouachita Baptist University. James Files is Assistant Professor of Accounting at OBU.

price is less than this interval, if any, is called a “shadow” and is represented by a line segment over the distance. The distance by which the high price is greater than this interval, if any, is called a “wick” and is represented by a line segment over the distance. Wicks and shadows can be of virtually any length, including zero.

The required data (from Commodity Systems, Inc., CSI) are easily obtainable for free on Yahoo Finance using the “Historical Price” option that appears as a menu item after the stock’s ticker symbol has been entered. Furthermore, the daily data are easily downloadable into Excel spreadsheet files and Chart Wizard for quick analysis. Better yet, Caginalp and Laurent (1998) and Horton (2008) provided simple decision rules that can be readily used in spreadsheets to evaluate the effectiveness of such trading rules. A short discussion of the candlestick signals and related decision rules follows.

Table I shows one week’s worth of daily data for IMAX Corporation. Figure 1 plots the candlestick chart for these data. This function is standard on Excel spreadsheets.

Candlesticks for which the market closed higher than it opened are white, while candlesticks for which the market closed down are black. Figure 1 shows two “Doji.” A doji is defined to be a session in which the daily closing price was the same as the daily opening price.

The subjective nature of candlestick charting might frustrate analysts. If students are required to plot the data for companies of their own choice, they will experience first-hand just how hard it is to see the signals that candlestick “experts” find. This approach is useful for actively involving students in the exercise and avoiding the use of a pedagogically sterile “black box.”

III. Methodology

Following Caginalp and Laurent (1998), Horton (2008) analyzed more than 300 stocks from Commodity Systems Inc. (CSI) via Yahoo Finance using the following “bull” or “bear” market signals. They found no predictive power from any of the candlestick signals and concluded in favor of weak market efficiency.

The following section, in which the market signals are described, follows Caginalp and Laurent and/or Horton very closely. These signals were presumably chosen over many others because they are the most objective of the candlestick signals and are therefore most readily programmed by the investor (or student).

Bull Market Signals:

- *Three White Soldiers (TWS)* – a downtrend followed by three long, white, candlesticks in a row which close at progressively higher prices
- *Three Inside Up (TIU)* – a downtrend followed by a black day that contains a small white day that succeeds it followed by a white candle that closes with a new high for the three days

- *Three Outside Up (TOU)* – a downtrend followed by a large white day that engulfs the first day's body amid rising prices and is followed by a white candle that closes with a new high for the three days.
- *Morning Star (MS)* – a downtrend continues in a long, black, day and is followed by a downward gap and a small body, either black or white, after which prices reverse, closing past the midpoint of the first day's body.

Bear Market Signals:

- *Three Black Crows (TBC)* – an uptrend followed by three long, black, candlesticks in a row which close at progressively lower prices.
- *Three Inside Down (TID)* – an uptrend followed by a white day that contains a small black day that succeeds it followed by a black candle that closes with a new high for the three days.
- *Three Outside Down (TOD)* – an uptrend followed by a large black day that engulfs the first day's body amid falling prices and is followed by a black candle that closes with a new low for the three days.
- *Evening Star (ES)* – an uptrend continues in a long, white, day and is followed by an upward gap and a small body, either black or white, after which prices reverse, closing past the midpoint of the first day's body.

A downtrend is defined as when the three-day moving average declines for at least five of six successive days. An uptrend is defined as when the three-day moving average declines for at least five of six successive days.

Caginalp and Laurent (1998) were very careful to derive decision rules to illustrate each signal. For example, the Three White Soldiers signal equates to the following nine inequalities:

$$\begin{aligned} C_i > O_i \text{ for } i = t+1, t+2, t+3 \\ C_{t+3} > C_{t+2} > C_{t+1} \\ C_{t+1} > O_{t+2} > O_{t+1} \\ C_{t+2} > O_{t+3} > O_{t+2} \end{aligned}$$

where C denotes closing price and O denotes opening price.

For the eight signals described above, Horton used Caginalp and Laurent's decision rules to detect the presence of bull and bear signals. In addition, he used the additional bear signal of the Doji described above in connection with Figure 1.

IV. The Spreadsheet Representation

Table II provides the basic price data downloaded into a spreadsheet directly from Yahoo Finance Historical Prices for the ticker symbol AA (Alcoa Aluminum).

Of course, the data continue for many rows. Considering the period from January 2, 1992, through March 13, 2007, would entail over 3,800 rows. Table III contains the Excel formulas for the first several rows of the columns that the students would construct. While the formulas appear complicated at first glance, they are actually no more than nested “IF,” “THEN,” and “OR” statements with additional use of means and absolute values. These columns contain all of the decision rules from Caginalp and Laurent (1998) and Horton (2008). The students would need to copy these formulas down the relevant number of rows.

Of most importance is the summary row, row 2. This row simply sums up the items in the columns with the number of uptrends (T), downtrends (U), the candlestick indicators’ accurate predictions of uptrends (V), and their accurate prediction of downtrends (W). As can be seen from the spreadsheet, out of 802 uptrends, the candlestick indicators predicted only thirty-five. Of the 751 downtrends, the indicators predicted only seventy-two. The other 1,446 missed trends represent lost opportunities for profits.

Perhaps more telling are the entries in the final two columns, X and Y. These two columns represent “false positives” in the sense that the candlestick indicators predicted a trend, but in the wrong direction. The candlestick indicators incorrectly predicted an uptrend twenty-five times in advance of an actual downtrend and incorrectly predicted seventy downtrends in advance of an actual uptrend. The model makes almost as many false signals as it does accurate signals. Further, the model makes numerous “false negative” signals, causing the investor to miss opportunities by doing nothing because the model is silent before an actual market movement. Table IV illustrates the “false positive”, “false negative”, “true positive” and “true negative” signals from this sample.

These results, readily obtainable by the student using commonly available software and data, indicate that the candlestick approach does not help in stock selection. In fact, any trading rule that can be expressed by a series of inequalities can be used with this approach, showing the student first-hand that stocks are indeed efficient.

Other candlestick indicators could be used, such as the harami, cross, and hanging man, but they are beyond the scope of this study since they have not yet appeared in the academic finance literature. Adherents of the Japanese Candlestick approach may point out additional signals that should be used to evaluate turning points. A useful follow-up to the approach outlined in this paper would be for students to investigate some other candlestick signals such as haramis, crosses, and hanging men and construct spreadsheets to evaluate their use. In addition, some rules-of-thumb regarding candlesticks, for example, the persistence of a particular pattern or combinations of signals, are difficult to observe without graphics. The instructor should also employ the charts to show students the folly of trying to “time the market.”

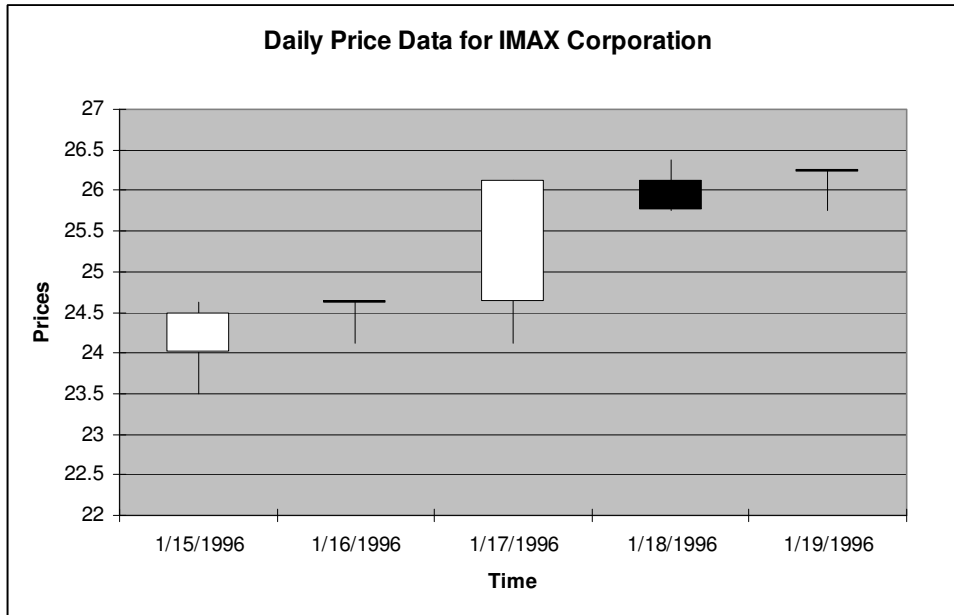
V. Conclusions

Japanese Candlestick Charting is an increasingly popular method for investors to try to make arbitrage profits in trading financial assets. Using open, close, high, and low prices, students can use decision rules from Caginalp and Laurent (1998) and Horton (2008) to evaluate the candlestick approach in particular and weak market efficiency in general. The data are readily available and Excel spreadsheets contain all the analytics that are necessary to convince students that past stock prices are of no value in predicting future stock prices.

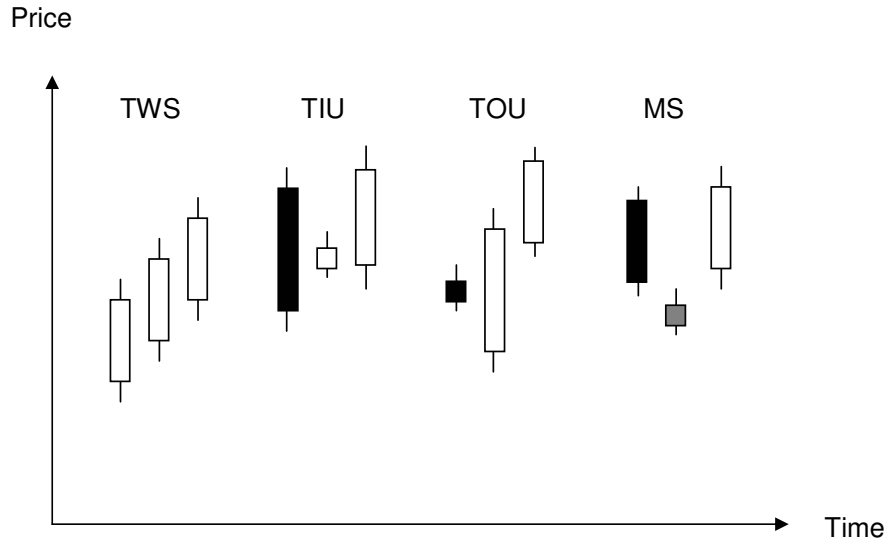
**Table I Daily Price Data for IMAX Corporation
January 15, 1996 – January 19, 1996**

Date	Open	High	Low	Close
1/15/1996	24	24.63	23.5	24.5
1/16/1996	24.63	24.63	24.12	24.63
1/17/1996	24.63	26.13	24.12	26.13
1/18/1996	26.13	26.37	25.75	25.75
1/19/1996	26.25	26.25	25.75	26.25

**Figure 1 Candlestick Chart for IMAX Corporation
January 15, 1996 – January 19, 1996**



**Figure 2 – Bull Market Signals
(preceding downtrends not shown)**



**Figure 3 – Bear Market Signals
(preceding uptrends not shown)**

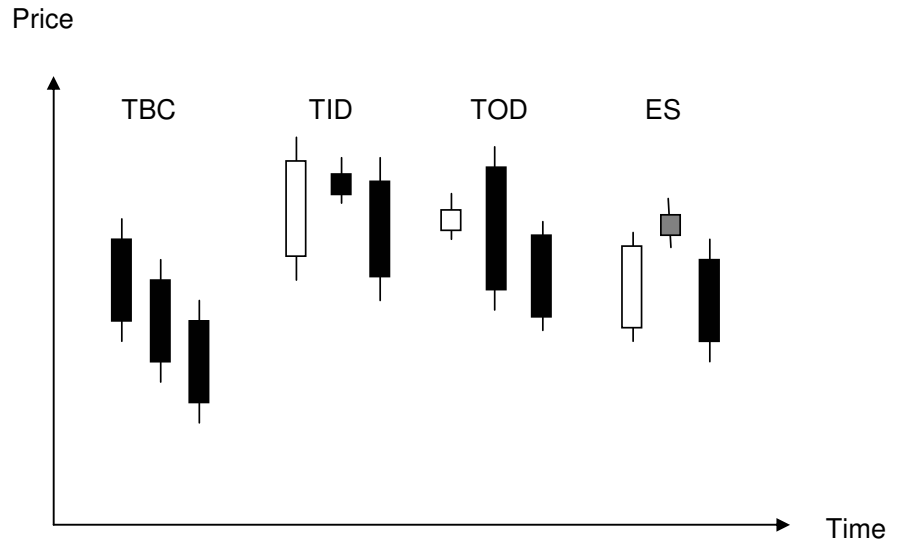


Table II Basic Price Data in Spreadsheet Form

	A	B	C	D	E
1					
2					
3					
4					
5					
6					
7					
8	Date	Open	High	Low	Close
9	1/2/1992	64	64	63.38	64
10	1/3/1992	64	64.62	63.63	64.62
11	1/6/1992	64.37	64.37	63.5	64.12
12	1/7/1992	64.12	65	63.75	64.12
13	1/8/1992	64.12	65.62	63.5	64.25
14	1/9/1992	64.12	64.12	62.38	63
15	1/10/1992	63	63	62.5	62.75
16	1/13/1992	62.75	62.75	61.5	61.75
17	1/14/1992	61.75	62.63	61	62.5
18	1/15/1992	62.5	68	62.5	67.12
19	1/16/1992	67.12	69.5	67	68
20	1/17/1992	68	70.25	67.25	69

Table III Decision Rule Formulas

	F	Formulas for F	G	Formulas for G
1				
2				
3				
4				
5	3 day		Change	
6	Moving		in 3 day	
7	Average		Moving	
8	Close		Average	
9				
10				
11	64.25	=AVERAGE(E9:E11)		
12	64.29	=AVERAGE(E10:E12)	0.04	=F12-F11
13	64.16	=AVERAGE(E11:E13)	-0.12	=F13-F12
14	63.79	=AVERAGE(E12:E14)	-0.37	=F14-F13
15	63.33	=AVERAGE(E13:E15)	-0.46	=F15-F14
16	62.50	=AVERAGE(E14:E16)	-0.83	=F16-F15
17	62.33	=AVERAGE(E15:E17)	-0.17	=F17-F16
18	63.79	=AVERAGE(E16:E18)	1.46	=F18-F17
19	65.87	=AVERAGE(E17:E19)	2.08	=F19-F18
20	68.04	=AVERAGE(E18:E20)	2.17	=F20-F19

Table III Decision Rule Formulas (continued)

	H	Formulas for H
5	Ex	
6	Post	
7	Up	
8	Trends	
9		
16		
17	0	=IF(AND(G17>0,G16>0,G15>0,G14>0,G13>0,G12>0),1,IF(AND(G17>0,G16<0,G15>0,G14>0,G13>0,G12>0),1,IF(AND(G17>0,G16>0,G15<0,G14>0,G13>0,G12>0),1,IF(AND(G17>0,G16>0,G15>0,G14<0,G13>0,G12>0),1,IF(AND(G17>0,G16>0,G15>0,G14>0,G13<0,G12>0),1,IF(AND(G17>0,G16>0,G15>0,G14>0,G13>0,G12<0),1,IF(AND(G17<0,G16>0,G15>0,G14>0,G13>0,G12>0),1,0))))))))))
18	0	=IF(AND(G18>0,G17>0,G16>0,G15>0,G14>0,G13>0),1,IF(AND(G18>0,G17<0,G16>0,G15>0,G14>0,G13>0),1,IF(AND(G18>0,G17>0,G16<0,G15>0,G14>0,G13>0),1,IF(AND(G18>0,G17>0,G16>0,G15<0,G14>0,G13>0),1,IF(AND(G18>0,G17>0,G16>0,G15>0,G14<0,G13>0),1,IF(AND(G18>0,G17>0,G16>0,G15>0,G14>0,G13<0),1,IF(AND(G18<0,G17>0,G16>0,G15>0,G14>0,G13>0),1,0))))))))))
19	0	=IF(AND(G19>0,G18>0,G17>0,G16>0,G15>0,G14>0),1,IF(AND(G19>0,G18<0,G17>0,G16>0,G15>0,G14>0),1,IF(AND(G19>0,G18>0,G17<0,G16>0,G15>0,G14>0),1,IF(AND(G19>0,G18>0,G17>0,G16<0,G15>0,G14>0),1,IF(AND(G19>0,G18>0,G17>0,G16>0,G15<0,G14>0),1,IF(AND(G19>0,G18>0,G17>0,G16>0,G15>0,G14<0),1,IF(AND(G19<0,G18>0,G17>0,G16>0,G15>0,G14>0),1,0))))))))))
20	0	=IF(AND(G20>0,G19>0,G18>0,G17>0,G16>0,G15>0),1,IF(AND(G20>0,G19<0,G18>0,G17>0,G16>0,G15>0),1,IF(AND(G20>0,G19>0,G18<0,G17>0,G16>0,G15>0),1,IF(AND(G20>0,G19>0,G18>0,G17<0,G16>0,G15>0),1,IF(AND(G20>0,G19>0,G18>0,G17>0,G16<0,G15>0),1,IF(AND(G20>0,G19>0,G18>0,G17>0,G16>0,G15<0),1,IF(AND(G20<0,G19>0,G18>0,G17>0,G16>0,G15>0),1,0))))))))))

Table III Decision Rule Formulas (continued)

	I	Formulas for I
5	Ex	
6	Post	
7	Up	
8	Trends	
9		
16		
17		=IF(AND(G17<0,G16<0,G15<0,G14<0,G13<0,G12<0),1,IF(AND(G17<0,G16>0,G15<0,G14<0,G13<0,G12<0),1,IF(AND(G17<0,G16<0,G15>0,G14<0,G13<0,G12<0),1,IF(AND(G17<0,G16<0,G15<0,G14>0,G13<0,G12<0),1,IF(AND(G17<0,G16<0,G15<0,G14<0,G13>0,G12<0),1,IF(AND(G17<0,G16<0,G15<0,G14<0,G13<0,G12>0),1,IF(AND(G17>0,G16<0,G15<0,G14<0,G13<0,G12<0),1,0))))))))))
18		=IF(AND(G18<0,G17<0,G16<0,G15<0,G14<0,G13<0),1,IF(AND(G18<0,G17>0,G16<0,G15<0,G14<0,G13<0),1,IF(AND(G18<0,G17<0,G16>0,G15<0,G14<0,G13<0),1,IF(AND(G18<0,G17<0,G16<0,G15>0,G14<0,G13<0),1,IF(AND(G18<0,G17<0,G16<0,G15<0,G14>0,G13<0),1,IF(AND(G18<0,G17<0,G16<0,G15<0,G14<0,G13>0),1,IF(AND(G18>0,G17<0,G16<0,G15<0,G14<0,G13<0),1,0))))))))))
19		=IF(AND(G19<0,G18<0,G17<0,G16<0,G15<0,G14<0),1,IF(AND(G19<0,G18>0,G17<0,G16<0,G15<0,G14<0),1,IF(AND(G19<0,G18<0,G17>0,G16<0,G15<0,G14<0),1,IF(AND(G19<0,G18<0,G17<0,G16>0,G15<0,G14<0),1,IF(AND(G19<0,G18<0,G17<0,G16<0,G15>0,G14<0),1,IF(AND(G19<0,G18<0,G17<0,G16<0,G15<0,G14>0),1,IF(AND(G19>0,G18<0,G17<0,G16<0,G15<0,G14<0),1,0))))))))))
20		=IF(AND(G20<0,G19<0,G18<0,G17<0,G16<0,G15<0),1,IF(AND(G20<0,G19>0,G18<0,G17<0,G16<0,G15<0),1,IF(AND(G20<0,G19<0,G18>0,G17<0,G16<0,G15<0),1,IF(AND(G20<0,G19<0,G18<0,G17>0,G16<0,G15<0),1,IF(AND(G20<0,G19<0,G18<0,G17<0,G16>0,G15<0),1,IF(AND(G20<0,G19<0,G18<0,G17<0,G16<0,G15>0),1,IF(AND(G20>0,G19<0,G18<0,G17<0,G16<0,G15<0),1,0))))))))))

Table III Decision Rule Formulas (continued)

	J	Formulas for J
5		
6	Three	
7	White	
8	Soldiers	
9		
16		
17		
18		
19	0	=IF(AND(I17=1,E17>B17,E18>B18,E19>B19,B18>B17, B18<E17,B19>B18,B19<E18,E19>E18,E18>E17),1,0)
20	0	=IF(AND(I18=1,E18>B18,E19>B19,E20>B20,B19>B18, B19<E18,B20>B19,B20<E19,E20>E19,E19>E18),1,0)

Table III Decision Rule Formulas (continued)

	K	Formulas for K
5		
6	Three	
7	Inside	
8	Up	
9		
16		
17		
18		
19	0	=IF(AND(I17=1,B17>E17,OR(B17>B18,B17=B18),B18>E17,B17>E18, OR(E18>E17,E18=E17),OR(B17=B18,E18<>E17),OR(E18=E17,B18<>B17), E19>B19,E19>B17),1,0)
20	0	=IF(AND(I18=1,B18>E18,OR(B18>B19,B18=B19),B19>E18,B18>E19, OR(E19>E18,E19=E18),OR(B18=B19,E19<>E18),OR(E19=E18,B19<>B18), E20>B20,E20>B18),1,0)

Table III Decision Rule Formulas (continued)

	L	Formulas for L
5		
6	Three	
7	Outside	
8	Up	
9		
16		
17		
18		
19	0	=IF(AND(I17=1,B17>E17,OR(E18>B17,E18=B17),OR(E17>B18,E17=B18),ABS(E18-B18)>ABS(E17-B17),E19>B19,E19>B18),1,0)
20	0	=IF(AND(I18=1,B18>E18,OR(E19>B18,E19=B18),OR(E18>B19,E18=B19),ABS(E19-B19)>ABS(E18-B18),E20>B20,E20>B19),1,0)

Table III Decision Rule Formulas (continued)

	M	Formulas for M
5		
6		
7	Morning	
8	Star	
9		
16		
17		
18		
19	0	=IF(AND(I17=1,B17>E17,ABS(B18-E18)>0,E17>E18,E17>B18,E19>B19,E19>(B17-E17)/2),1,0)
20	0	=IF(AND(I18=1,B18>E18,ABS(B19-E19)>0,E18>E19,E18>B19,E20>B20,E20>(B18-E18)/2),1,0)

Table III Decision Rule Formulas (continued)

	N	Formulas for N
5		
6	Three	
7	Black	
8	Crows	
9		
16		
17		
18		
19	0	=IF(AND(H17=1,E17<B17,E18<B18,E19<B19,B18<B17, B19<B18,B19>E18,E17>E18,E18>E19,B17>B18,B18>E17,B18>B19),1,0)
20	0	=IF(AND(H18=1,E18<B18,E19<B19,E20<B20,B19<B18, B20<B19,B20>E19,E18>E19,E19>E20,B18>B19,B19>E18,B19>B20),1,0)

Table III Decision Rule Formulas (continued)

	O	Formulas for O
5		
6	Three	
7	Inside	
8	Down	
9		
16		
17		
18		
19	0	=IF(AND(H17=1,E17>B17,E17>B18,OR(B18>B17,B18=B17), OR(E17>E18,E17=E18),E18>B17,OR(B17=B18,E17<>E18), OR(E18=E18,B17<>B18),B19>E19,B17>E19),1,0)
20	0	=IF(AND(H18=1,E18>B18,E18>B19,OR(B19>B18,B19=B18), OR(E18>E19,E18=E19),E19>B18,OR(B18=B19,E18<>E19), OR(E19=E19,B18<>B19),B20>E20,B18>E20),1,0)

Table III Decision Rule Formulas (continued)

	P	Formulas for P
5		
6	Three	
7	Outside	
8	Down	
9		
16		
17		
18		
19	0	=IF(AND(I17=1,E16>B16,OR(B17>E16,B17=E16),OR(B16>E17,B16=E17),ABS(E17-B17)>ABS(E16-B18),B18>E18,E17>E18),1,0)
20	0	=IF(AND(I18=1,E17>B17,OR(B18>E17,B18=E17),OR(B17>E18,B17=E18),ABS(E18-B18)>ABS(E17-B19),B19>E19,E18>E19),1,0)

Table III Decision Rule Formulas (continued)

	Q	Formulas for Q	R	Formulas for R
5				
6				
7	Evening			
8	Star		Doshi	
9				
16				
17				
18				
19	0	=IF(AND(H17=1,E17>B17,ABS(B18-E18)>0,E18>E17,B18>E17,B19>E19,E19<(E17-B17)/2),1,0)	0	=IF(B19=E19,1,0)
20	0	=IF(AND(H18=1,E18>B18,ABS(B19-E19)>0,E19>E18,B19>E18,B20>E20,E20<(E18-B18)/2),1,0)	0	=IF(B20=E20,1,0)

Table III Decision Rule Formulas (continued)

	S	Formulas for S
5	Forward	
6	3 day	
7	Moving	
8	Average	
9	64.247	=AVERAGE(E9:E11)
10	64.287	=AVERAGE(E10:E12)
11	64.163	=AVERAGE(E11:E13)
12	63.790	=AVERAGE(E12:E14)
13	63.333	=AVERAGE(E13:E15)
14	62.500	=AVERAGE(E14:E16)
15	62.333	=AVERAGE(E15:E17)
16	63.790	=AVERAGE(E16:E18)
17		=AVERAGE(E17:E19)
	65.873	
18	68.040	=AVERAGE(E18:E20)
19	68.707	=AVERAGE(E19:E21)
20	68.123	=AVERAGE(E20:E22)

Table III Decision Rule Formulas (continued)

	T	Formulas for T
1	Uptrends	
2	802	=SUM(T9:T3831)
5	Ex	
6	Ante	
7	Up	
8	Trends	
9		
15		=IF(OR(AND(S21>S20,S20>S19,S19>S18,S18>S17,S17>S16,S16>S15), AND(S21>S20,S20<S19,S19>S18,S18>S17,S17>S16,S16>S15), AND(S21>S20,S20>S19,S19<S18,S18>S17,S17>S16,S16>S15), AND(S21>S20,S20>S19,S19>S18,S18<S17,S17>S16,S16>S15), AND(S21>S20,S20>S19,S19>S18,S18>S17,S17<S16,S16>S15), AND(S21>S20,S20>S19,S19>S18,S18>S17,S17>S16,S16<S15)),1, 0 IF(AND(S21<S20,S20>S19,S19>S18,S18>S17,S17>S16,S16>S15),1,0))
16		=IF(OR(AND(S22>S21,S21>S20,S20>S19,S19>S18,S18>S17,S17>S16), AND(S22>S21,S21<S20,S20>S19,S19>S18,S18>S17,S17>S16), AND(S22>S21,S21>S20,S20<S19,S19>S18,S18>S17,S17>S16), AND(S22>S21,S21>S20,S20>S19,S19<S18,S18>S17,S17>S16), AND(S22>S21,S21>S20,S20>S19,S19>S18,S18<S17,S17>S16), AND(S22>S21,S21>S20,S20>S19,S19>S18,S18>S17,S17<S16)),1, 0 IF(AND(S22<S21,S21>S20,S20>S19,S19>S18,S18>S17,S17>S16),1,0))
17		=IF(OR(AND(S23>S22,S22>S21,S21>S20,S20>S19,S19>S18,S18>S17), AND(S23>S22,S22<S21,S21>S20,S20>S19,S19>S18,S18>S17), AND(S23>S22,S22>S21,S21<S20,S20>S19,S19>S18,S18>S17), AND(S23>S22,S22>S21,S21>S20,S20<S19,S19>S18,S18>S17), AND(S23>S22,S22>S21,S21>S20,S20>S19,S19<S18,S18>S17), AND(S23>S22,S22>S21,S21>S20,S20>S19,S19>S18,S18<S17)),1, 0 IF(AND(S23<S22,S22>S21,S21>S20,S20>S19,S19>S18,S18>S17),1,0))
18		=IF(OR(AND(S24>S23,S23>S22,S22>S21,S21>S20,S20>S19,S19>S18), AND(S24>S23,S23<S22,S22>S21,S21>S20,S20>S19,S19>S18), AND(S24>S23,S23>S22,S22<S21,S21>S20,S20>S19,S19>S18), AND(S24>S23,S23>S22,S22>S21,S21<S20,S20>S19,S19>S18), AND(S24>S23,S23>S22,S22>S21,S21>S20,S20<S19,S19>S18), AND(S24>S23,S23>S22,S22>S21,S21>S20,S20>S19,S19<S18)),1, 0 IF(AND(S24<S23,S23>S22,S22>S21,S21>S20,S20>S19,S19>S18),1,0))

Table III Decision Rule Formulas (continued)

	U	Formulas for U
1	Downtrends	
2	751	=SUM(U9:U3831)
5	Ex	
6	Ante	
7	Down	
8	Trends	
9		
15		=IF(OR(AND(S21<S20,S20<S19,S19<S18,S18<S17,S17<S16,S16<S15), AND(S21<S20,S20>S19,S19<S18,S18<S17,S17<S16,S16<S15), AND(S21<S20,S20<S19,S19>S18,S18<S17,S17<S16,S16<S15), AND(S21<S20,S20<S19,S19<S18,S18>S17,S17<S16,S16<S15), AND(S21<S20,S20<S19,S19<S18,S18<S17,S17>S16,S16<S15), AND(S21<S20,S20<S19,S19<S18,S18<S17,S17<S16,S16>S15)),1, 0 IF(AND(S21>S20,S20<S19,S19<S18,S18<S17,S17<S16,S16<S15),1,0))
16		=IF(OR(AND(S22<S21,S21<S20,S20<S19,S19<S18,S18<S17,S17<S16), AND(S22<S21,S21>S20,S20<S19,S19<S18,S18<S17,S17<S16), AND(S22<S21,S21<S20,S20>S19,S19<S18,S18<S17,S17<S16), AND(S22<S21,S21<S20,S20<S19,S19>S18,S18<S17,S17<S16), AND(S22<S21,S21<S20,S20<S19,S19<S18,S18>S17,S17<S16), AND(S22<S21,S21<S20,S20<S19,S19<S18,S18<S17,S17>S16)),1, 0 IF(AND(S22>S21,S21<S20,S20<S19,S19<S18,S18<S17,S17<S16),1,0))
17		=IF(OR(AND(S23<S22,S22<S21,S21<S20,S20<S19,S19<S18,S18<S17), AND(S23<S22,S22>S21,S21<S20,S20<S19,S19<S18,S18<S17), AND(S23<S22,S22<S21,S21>S20,S20<S19,S19<S18,S18<S17), AND(S23<S22,S22<S21,S21<S20,S20>S19,S19<S18,S18<S17), AND(S23<S22,S22<S21,S21<S20,S20<S19,S19>S18,S18<S17), AND(S23<S22,S22<S21,S21<S20,S20<S19,S19<S18,S18>S17)),1, 0 IF(AND(S23>S22,S22<S21,S21<S20,S20<S19,S19<S18,S18<S17),1,0))
18		=IF(OR(AND(S24<S23,S23<S22,S22<S21,S21<S20,S20<S19,S19<S18), AND(S24<S23,S23>S22,S22<S21,S21<S20,S20<S19,S19<S18), AND(S24<S23,S23<S22,S22>S21,S21<S20,S20<S19,S19<S18), AND(S24<S23,S23<S22,S22<S21,S21>S20,S20<S19,S19<S18), AND(S24<S23,S23<S22,S22<S21,S21<S20,S20>S19,S19<S18), AND(S24<S23,S23<S22,S22<S21,S21<S20,S20<S19,S19>S18)),1, 0 IF(AND(S24>S23,S23<S22,S22<S21,S21<S20,S20<S19,S19<S18),1,0))

Table III Decision Rule Formulas (continued)

	V	Formulas for V
1		
2	35	=SUM(V9:V3831)
5	Accurate	
6	Forecast	
7	Of	
8	Uptrend	
9		
15		
16		
17	0	=IF(OR(J19=1,K19=1,L19=1,M19=1),IF(OR(T20=1,T21=1,T22=1,T23=1,T24=1,T25=1,T26=1),1,0),0)
18	0	=IF(OR(J20=1,K20=1,L20=1,M20=1),IF(OR(T21=1,T22=1,T23=1,T24=1,T25=1,T26=1,T27=1),1,0),0)

	W	Formulas for W
1		
2	72	=SUM(W9:W3831)
5	Accurate	
6	Forecast	
7	of	
8	Downtrend	
9		
15		
16		
17	0	=IF(OR(N19=1,O19=1,P19=1,Q19=1,R19=1),IF(OR(U20=1,U21=1,U22=1,U23=1,U24=1,U25=1,U26=1),1,0),0)
18	0	=IF(OR(N20=1,O20=1,P20=1,Q20=1,R20=1),IF(OR(U21=1,U22=1,U23=1,U24=1,U25=1,U26=1,U27=1),1,0),0)

Table III Decision Rule Formulas (continued)

	X	Formulas for X
1		
2	25	=SUM(X9:X3831)
4	Bull	
5	Signal	
6	w/Down	
7	Trend	
8	Following	
15		
16		
17	0	=IF(OR(J19=1,K19=1,L19=1,M19=1),IF(OR(U20=1,U21=1,U22=1,U23=1,U24=1,U25=1,U26=1),1,0),0)
18	0	=IF(OR(J20=1,K20=1,L20=1,M20=1),IF(OR(U21=1,U22=1,U23=1,U24=1,U25=1,U26=1,U27=1),1,0),0)

Table III Decision Rule Formulas (continued)

	Y	Formulas for Y
1		
2	70	=SUM(Y9:Y3831)
4	Bear	
5	Signal	
6	w/Up	
7	Trend	
8	Following	
15		
16		
17	0	=IF(OR(N19=1,O19=1,P19=1,Q19=1,R19=1),IF(OR(T20=1,T21=1,T22=1,T23=1,T24=1,T25=1,T26=1),1,0),0)
18	0	=IF(OR(N20=1,O20=1,P20=1,Q20=1,R20=1),IF(OR(T21=1,T22=1,T23=1,T24=1,T25=1,T26=1,T27=1),1,0),0)

Table IV Summary of True vs False Signals

Panel A Illustration of True vs Negative signals

	Actual Market Movements		
Model Predictions	Uptrend	Downtrend	No Change
Uptrend	TP	FP	FP
Downtrend	FP	TP	FP
No Change	FN	FN	TN

TP= true positive FP= false positive TN= true negative FN= false negative

Panel B Actual Sample Results

	Actual Market Movements		
Model Predictions	Uptrend	Downtrend	No Change
Uptrend	35 (3%)	25 (3%)	FP
Downtrend	70 (9%)	72 (10%)	FP
No Change	697 (87%)	654 (87%)	TN
Totals	802 (100%)	751 (100%)	

Reference

- Bessembinder, Hendrik, and Kalok Chan (1998) “Market Efficiency and the Returns to Technical Analysis,” *Financial Management* 27:2 (February), 5-17.
- Caginalp, G., and H. Laurent (1998) “The Predictive Power of Price Patterns,” *Applied Mathematical Finance* 5, 181–205.
- Corrado, Charles J. and Bradford D. Jordan (2005) *Fundamentals of Investments: Valuation and Management*, Third Edition. New York: McGraw-Hill Irwin.
- Elton, Edwin J., Martin J. Gruber, and Christopher R. Blake (1998) “Survivor Bias and Mutual Fund Performance,” *Review of Financial Studies* 9:4 (Winter), 1097-1120.
- Fama, Eugene. F., (1970) "Efficient Capital Markets: A Review of Theory and Empirical Work," *Journal of Finance*, 25:2, 383-417.
- Horton, Marshall J. (2008) “Stars, Crows, and Doshi: The Use of Candlesticks in Stock Selection,” *Quarterly Review of Economics and Finance* (forthcoming)
- Lo, Andrew W., Harry Mamaysky, and Jiang Wang (2000) “Foundations of Technical Analysis: Computational Algorithms, Statistical Inference, and Empirical Implementation,” *Journal of Finance* LV:4 (August), 1705-1765.
- Malkiel, Burton G. (1973) *A Random Walk Down Wall Street*. New York: W. W. Norton and Company, Inc.
- Marshall, Ben R., Martin R. Young, and Lawrence C. Rose (2006) “Candlestick Technical Trading Strategies: Can They Create Value for Investors?” *Journal of Banking and Finance*, 30:8 (August), 2303-2323.
- Mayo, Herbert B. (2006) *Investments: An Introduction*, Eighth Edition. Mason, Ohio: Thomson South-Western.
- Nison, Steve (1991) *Japanese Candlestick Charting Techniques: A Contemporary Guide to the Ancient Investment Techniques of the Far East*. New York: New York Institute of Finance.
- Pring, Martin J. (1991) *Technical Analysis Explained: The Successful Investor’s Guide to Spotting Investment Trends and Turning Points*, Third Edition. New York: McGraw-Hill.
- Ready, Mark J. (2002) “Profits from Technical Trading Rules,” *Financial Management* (Autumn), 5-23.

- Schwager, Jack D. (1989) *Market Wizards: Interviews with Top Traders*. New York: HarperBusiness.
- Schwager, Jack D. (1992) *The New Market Wizards: Conversations with America's Top Traders*. New York: HarperBusiness.
- Strong, Robert A. (2007) *Practical Investment Management, Fourth Edition*. Mason, Ohio: Thomson South-western.
- Weber, Marsha (2007) "Teaching and Reinforcing Professional Skills in the Finance Classroom," *Advances in Financial Education* 5:1 (Spring), 1-28.
- Yatrakis, Pan G., and Albert A. Williams (2008) "Information Conveyed by Japanese Candlestick Chart Patterns: An Apparent Anomaly in the Weak Form of the Efficient Market Hypothesis," *Business Quest*
<http://www.westga.edu/~bquest/2008/research08.htm>