Abstract

In recent years, Japanese candlestick charts have come into use in this country. This type of candlestick chart, developed in Japan in the late 1960s, is based on the belief that the basic information on future market direction is reflected in the daily price range. This belief is supported by statistical tests reported in this paper. Even though this paper indicates no statistical significance, several recent studies have produced positive results. These studies tend to suggest that candlestick patterns may have some predictive power (Nishida and Polcino, 1984; Lukac, et. al., 1986; Elam and Vaught, 1990).

Recently, a new chart has been introduced into limited use in this country—the Japanese candlestick chart. While they are new in the United States, candlestick charts are certainly not new. Japanese candlestick charts are used by brokers, investors, and hedgers. A technical study of the effectiveness of these charts was undertaken. The study was based on the belief that the basic information on future market direction is reflected in the daily price range. This belief is supported by statistical tests reported in this paper. Even though this paper indicates no statistical significance, several recent studies have produced positive results. These studies tend to suggest that candlestick patterns may have some predictive power (Nishida and Polcino, 1984; Lukac, et. al., 1986; Elam and Vaught, 1990).

Introduction

Traditional methods for charting futures prices in the United States use point-and-figure or bar charts. These charts are a major element of technical trading systems used by brokers, investors, and hedgers. A technical study of the effectiveness of these charts was undertaken. The study was based on the belief that the basic information on future market direction is reflected in the daily price range. This belief is supported by statistical tests reported in this paper. Even though this paper indicates no statistical significance, several recent studies have produced positive results. These studies tend to suggest that candlestick patterns may have some predictive power (Nishida and Polcino, 1984; Lukac, et. al., 1986; Elam and Vaught, 1990).

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Nison was the first American to perform serious research on Japanese candlestick charts and is still the nation's leading expert on the subject. His books, articles, and pamphlets dealing with candlestick analysis were heavily drawn on for this study (Nison 1981a, b: 1992).

Williams is another technical analyst who has conducted research on the profitability of candlestick charts. He identified different market levels and identified candlestick patterns in each individual bullish and bearish market. He also identified the change in price one, three, and seven days after the signal occurred. Based on his candlestick theory, he identified signals correctly predicted price movement in selected markets. He concluded that candlestick chart patterns are consistent with reality and can be used to make consistent and profitable trading with any additional technical analysis. He did, however, feel that candlestick patterns warranted further study. This study will continue candlestick research by attempting to answer the question: Do candlestick patterns exist in the cotton futures market? Thirteen patterns were identified using daily cotton futures price data for the period 1973-1990.

Candlestick Patterns

Candlestick patterns show the relationship between the open, close, high, and low prices of a single day's trading. The pattern is represented by a rectangular box. This is referred to as the real body of the candlestick. Figure 1 illustrates the differences between traditional Western bar charts and Japanese candlestick charts.

Each line represents a period of trading. This study uses daily data, but candlestick charts can also be used for weekly or monthly periods. If the open is higher, the real body is colored black (Figure 1). If the open is lower, the real body is colored white. The differences between the top and bottom of the real body may be high and low are represented by straight lines referred to as the shadows of the candle. The various candlestick pattern are identified in Nison (1991a, b). Two examples of candlestick patterns are the bearish hanging and the bullish engulfing pattern (Figures 2 and 3).

Candlestick patterns can be divided into two categories: bullish and bearish patterns. A reversal pattern indicates that the direction of the market is about to change, whereas a continuation pattern indicates that the market is likely to continue in the same direction as previously. For instance, a continuation pattern in an uptrend indicates that the market will continue to move up. If a trader has a buy position in the market, a continuation pattern occurs. The trader should continue to hold the position in anticipation of further price increases. A reversal pattern is identified by a candlestick pattern, dark cloud cover, upside gap two crows, evening not stumped, evening star, shooting star, and tweezer top. While Nison did not stipulate the length of the trend that validates a candlestick pattern, he did make it clear that a consistent trend must be present in order for research, trend is defined in two ways. The first is by identifying a significant trend. This method of identifying trends limits valid signals to periods of large price movement in a short amount of time. This produces signals that follow "spurs" in the market.

The second method of identifying trends consists of extending the trend length to 20 days and increasing the required price move to $6/cwt. Bullish signals still require a downtrend, and bearish signals require an uptrend. This method produces signals after longer, more consistent trends in the market. Williams's study did not require these trends for valid candlestick patterns. The inclusion of the trends in this study will decrease the reliability of candlestick signals per contract, and, according to Nison, will help increase the reliability of candlestick reversal patterns.

Data Collection and Pattern Recognition

The 13 candlestick patterns discussed above were programmed individually in the MetaStock technical trading analysis program. (MetaStock Professional 3.0 is a computer program used to develop personalized trading rules and to calculate profits/losses from these rules—available from Equis International, Salt Lake

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The MetaStock program grouped all buy and sell signals together and searched each cotton contract from 1973 to 1990. The program first checked for a trend (as defined previously). When a trend was identified, the MetaStock program then determined if a candlestick signal followed that trend. Signals that followed these trends were considered valid and MetaStock marked the date on which the signal occurred.

Signals were marked on an "indicator" chart that was displayed with the price data (Figure 4). This indicator chart plotted a value of -1 when a sell signal was identified and +1 when a buy signal was confirmed. Days on which no signal occurred were given the default value of zero.

By analyzing the indicator chart, we recorded the day that each signal occurred and transferred this date into a spreadsheet containing the same contract that the MetaStock analyzed. Buy signals were marked in the spreadsheet with +1 and sell signals were marked with -1. This process was repeated for each contract on the 5-day, and on the 20-day time frame. The spreadsheet was then used to calculate price changes for each date, and once a day, daily price changes were calculated.

Cotton futures trade five contracts: March, May, July, October, and December. Because futures contracts which trade at the same time are closely related in price movements, a method had to be devised to move from one contract to another without imposing a move to position in the cotton market. The most widely used method is to buy or sell the May contract and hold it for delivery day of the May contract, and then roll it into the next month's contract. For instance, if we held a position in the May cotton contract on the first day of May and that day (June), the May contract was liquidated and the long position moved to the June contract.

Market Efficiency

Market efficiency refers to the ability of a market to reflect new information quickly and accurately in price changes. Efficient markets are a necessity for firms that base management decisions on market performance. Uninformed traders can profit from technical trading if the door for profits from technical trading is opened. If trading technical signals, such as candlesticks, can yield profits significantly above zero, then pricing is not efficient in the market.

An efficient market was defined by Fama (1970) as a market in which the price fully reflects all information that is relevant to the valuation of a security. As a result, "outperform" the market. Outperforming the market means realizing a return that exceeds the market return after adjusting for transaction costs and the risk level accepted by the investor. To test market efficiency, the three forms of market efficiency were tested:

1. Market efficiency for security (or futures) prices.
2. Weak-form efficiency means that the price of the security fully reflects the price and trading history of the security. Semi-strong-form efficiency means that prices of the security fully reflects all publicly available information. Strong-form efficiency exists in a market in which the price fully reflects all information whether or not it is publicly available.

This study of candlesticks is a test of weak-form market
efficiency because it uses past price
to predict future price movement.

The hypothesis to test weak-form market
efficiency was as follows: Can the trading system above return to risk (Lukac et al., 1998) return to zero? This hypothesis states that the positively correlated to the risk involved in the riskiness of an investment increases, the return must increase in order to attract.

Modern concepts of risk are based on statistical models such as the capital asset pricing model (CAPM). The CAPM measures risk using the covariance of returns of an asset and returns of the market. The risk of the market is measured by the S&P 500 index, divided by the returns of the market. This is called the risk of the investment, and is symbolized by:

\[ b = \text{COV}(R_t, R_m) \]

\[ \text{VAR}(R_t) \]

Systematic risk is measured from a regression of (return on the investment) on \( R_m \), the market risk minus the risk less (T-bill) rate:

\[ R_f = a + b(R_m - \text{T-bill}) + \text{error} \]

The intercept term \( a \) is the estimate of excess return, and if pricing is efficient, we would expect it to be approximately equal to zero for a futures investment. Eam and Vaught (1998) estimated this regression model for six commodities. Risk for a portfolio of futures contracts traded with a technical trading strategy (10-day channel) of cotton, soybeans, and Eam and Vaught estimated the excess returns for the four-commodity portfolio, using the a-value from the regression model. They tested the null hypothesis that the expected return of \( R_f \) is zero and thus rejected the null hypothesis of weak-form market efficiency for the four markets combined (corn, soybean, and cotton). This conclusion is consistent with that of other studies on technical trading strategies (Neftci and Polacino, 1998, Lukac et al., 1998). In contrast, the rejection of weak-form efficiency is not supported by a number of studies (see references in Lomax, 1992).

Trading Results

Results from the study on the 13 candlestick signals displayed in Table 1. This table contains the average change in price after a candlestick signal was given.

A position was taken at the opening price on the 13 candlestick signals on the 20 trading days after the candlestick was identified. The results were averaged and 14 days later. A position was closed at the closing price of that day. The t-value test shows that returns are equal to zero at the tailed significance level.

Table 1: Critical t-values for a 1% significance level. A calculated t-value greater than critical t-value is required to reject the hypothesis of weak-form market efficiency.

This table shows that the average changes in price were followed by a buy signal with 5-day and 20-day trends are 5.81/cwt and 5.24/cwt, respectively. The change in price was significant for sell signals on day 5. The change in price after three days for sell signals preceded a significant increase in the price of cotton. The critical t-value at the 5% significance level is 1.86 for a one-tailed test.
Summary and Conclusions

The results of the t-tests in this study were disappointing. When indicator charts were compared to price charts at the outset of this study (Figure 4), it appeared that candlestick signals did indeed accurately predict changes in price. The statistical analysis, however, did not confirm this observation. The remaining question is: If candlestick charts can predict market movement, what can be done to take advantage of this?

Several trading tools can be combined with candlestick analysis (as suggested by Nison, 1991b), and this might increase the predictive accuracy of candlestick charts. First, a stop-loss order could be added to prevent the user from incurring large losses and increase the average profit per trade. Another approach could be to integrate candlestick charts into a moving average system, adding the requirement that a candlestick signal should be followed only if the trading position is consistent with the average. This would allow for the combination of the two systems and determine if some combination is more predictive than others.

There is room for more research, but the system for analyzing candlestick patterns needs improvement. The MetaStock computer program was adequate for locating the trends and patterns, but manually transferring data into spreadsheets of price data was time-consuming and cumbersome. A program is needed that is better designed to analyze candlestick charts.

Do candlestick price charts, as a whole, have any significant predictive value in the cotton futures market? As analyzed in this study, no. We feel, however, that future research might prove otherwise.

References


The bullish engulfing pattern occurs at the bottom of a downtrend. It is characterized by a black body that is engulfed the next day by a long white body.

The bullish engulfing pattern indicates that prices in the downtrend will reverse and begin to rise. A bullish engulfing pattern is shown below in the January 1987 contract.

Figure 3. An example of a bullish engulfing pattern.

Figure 4. MetaStock candlestick and indicator charts.