TESTING EFFICIENCY OF THE COTTON FUTURES MARKET USING JAPANESE CANDLESTICK CHARTS

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Abstract

In recent years Japanese candlestick charts have come into use in this country. This study used candlestick charts in simulated trading of cotton futures from 1973 to 1990. While candlestick chartists claim that candlestick patterns can predict turns in the market, statistical tests reported in this paper indicate otherwise. Even though this study produced no conclusive evidence that candlestick patterns have predictive value in the cotton futures market, we strongly feel that further study is needed.

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 trading system is an approach to the market which relies on the belief that the best information on future market direction is the past history of the price itself. While it is a widely held belief that price movements in futures markets are random, and therefore impossible to predict accurately, several recent studies have produced results which tend to suggest otherwise (Neftci and Policano, 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 price charts are believed to have originated with the Japanese rice market around 1750. Although the Japanese were not the first to trade forward contracts (the Dutch were in the 1500's), they were the first to use technical analysis. Candlestick charts evolved from line charts which were used for the first rice charts (Nison 1991a,b; 1992). Shimizu published the first book in English on candlestick charts in 1986. Since that time, candlesticks have increased in use in this country.

Nison was the first American to perform serious research on 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 1991a,b; 1992).

Williams is another technical analyst who has conducted research on the profitability of candlestick charts. He drew from Shimizu to identify candlestick patterns in several different markets. Williams (1991) identified each individual bullish and bearish pattern, and recorded the change in price one, three, and seven days after the signal occurred. Based on candlestick theory, the price should decline after sell signals and increase after buy signals. While Williams found that some signals correctly predicted price movement in selected markets, he concluded that candlestick chart patterns were too erratic and vague for trading with any consistent effectiveness. He did, however, feel that candlesticks warranted further study.

This study will continue candlestick research by attempting to answer the question: Do candlestick patterns, as a whole, have any significant predictive value in the cotton futures market? Thirteen candlestick patterns (seven bearish and six bullish) were analyzed using daily cotton futures price data for the period 1973-1990.

Candlestick Patterns

Candlestick patterns show the relationship between the open and close prices of a single day of trading. The difference between the open and the close of the day 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 than the close, the real body is colored black (Figure 1). If the open is less than the close, the real body is clear or white. The differences between the real body and the high and low are represented by straight lines referred to as the shadows of the candle. The various candlestick patterns are identified in Nison (1991a,b). Two examples of candlestick patterns are the bearish hanging man and the bullish engulfing pattern (Figures 2 and 3).

Candlestick patterns can be divided into two categories--reversal patterns and continuation patterns. A reversal patten indicates that the direction of the market is about to change, whereas a continuation pattern indicates that the market is likely to continue moving 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 and a continuation pattern occurs, the trader should continue to hold the buy position in anticipation of further price increase. This study deals only with reversal patterns. A reversal pattern is interpreted by a candlestick technician as indicating that the market is at, or near, a top or bottom. If a market is in an uptrend, and a reversal pattern occurs, this indicates that the market is likely to reverse direction and move lower. After formation of a reversal pattern, a position can be taken in the market at the open price on the following day.

The bullish candlestick patterns that we identified in this study are: hammer, engulfing pattern, morning star, piercing line, doji star, and tweezer bottom; and the bearish patterns are: hanging man, engulfing pattern, dark cloud cover, upside gap two crows, 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 significant trend must be present in order for a candlestick reversal pattern to be valid. In this research, trend is defined in two ways. The first is to stipulate that all valid bullish candlestick patterns must be preceded by a downtrend in cotton futures prices of $3 per 100 pounds (cwt) or more over a five-day period. In contrast all bearish signals must be preceded by an uptrend of $3/cwt or more over five days. 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 "spurts" 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. William's study did not require these trends for valid candlestick patterns. The inclusion of the trends in this study will decrease the total number 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

City, UT.) 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 identified. 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 MetaStock analyzed. Buy signals were marked in the spreadsheet with +1 and sell signals were marked with -1. This process was repeated twice on each contract--once for buy and sell signals after the 5-day trend, and once for buy and sell signals following the 20-day trend. The spreadsheet was then used to calculate price changes for every date that was preceded by +1 or -1 (a buy or sell signal occurred on that day). Price changes were calculated 3, 7, and 14 days later.

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 movement, a method had to be devised to move from one contract to another without holding a position in two contracts at once. We considered developing a continuous contract that could be easily analyzed (Pelletier, 1983); but the prices from such a contract are weighted averages of prices from two contracts and thus are not actual prices traded in the market. Ma, Mercer, and Walker (1992) state that there is no good method of converting futures prices to a continuous contract for technical analysis. But the authors also state that the best method of those available involves simply switching from contract to contract on the first delivery day of the contract. This is defined for cotton contracts as the first business day of the contract month. For instance, if we held a position in the March cotton contract on the first day of March, we would liquidate our position and move to the May contract and wait for the next signal. The May contract was traded until May 1st, a period of two months. Thus, each contract was traded for a two- or three-month period while the contract was "nearby." The drawback to this method of continuous contracting is that transaction fees are increased as each contract is rolled over into the nearby contract. This is, however, a very realistic method of trading for large volume traders, such as large independent traders or futures fund managers (Lukac et. al., 1986).

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 prices. When markets become non-efficient, 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, it is not possible for investors to consistently "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. Fama defined three forms of market efficiency for security (or futures) prices. 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 the price 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 data to predict future price movement.

The hypothesis to test weak-form market efficiency stated as follows: Can the trading system earn a return above the return to risk? (Lukac et. al., 1986). The return to risk refers to the idea that return is positively correlated to the risk involved. That is, as the riskiness of an investment increases, the expected return must increase in order to attract investors.

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

$$b = \frac{COV\ (R_i, R_m)}{VAR\ (R_m)}$$

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

$$R_i = a + b(R_m - \text{T-bill rate}) + \text{error}$$

The intercept term "a" is the estimate of excess return, and if pricing is efficient, we would expect "a" to be approximately equal to zero for a futures market investment. Elam and Vaught (1990) used this regression model to measure systematic risk for a portfolio of four futures contracts traded with a technical trading scheme (10-day channel). They found that technical trading returns had a b-value not significantly different from zero, which indicates that trading commodity futures has no risk in relationship to market movement. Therefore, any returns significantly higher than zero would constitute significant profits, taking risk into consideration.

Elam and Vaught estimated the excess returns for the four-commodity portfolio, using the a-value from the regression model. They found excess returns significantly greater than the expected return of zero and thus rejected the null hypothesis of weak-form market efficiency for the four markets combined (live cattle, silver, soybeans, and sugar). This conclusion is consistent with that of some other studies of technical trading strategies (Neftci and Policano, 1984; Lukac, et.al., 1986). In contrast, the rejection of weak-form efficiency is not supported by a number of studies (see references in Kamara, 1982).

Trading Results

Results from trading the 13 candlestick signals are 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 day following a candlestick pattern and the change in price was examined 3, 7, and 14 days later. A position was closed at the closing price of that day. The t-values test the hypothesis that returns are equal to zero for trading candlestick signals is also listed. For sample size n=49 (largest n in Table 1), the critical t-value at the 5-percent significance level is 1.68 for a one-tail test. A calculated t-value greater than the critical t-value is required to reject the hypothesis of weak-form market efficiency.

This table shows that the average changes in price after 7 days following a buy signal with 5-day and 20-day trends are $.81/cwt and $1.17/cwt, respectively. These values, however, are not significant. The average price change following sell signals in the same categories are also interesting. The changes equal decreases of $.48/cwt and $.34/cwt. In contrast, the average price change after three days for sell signals preceded by a 20-day trend is almost significant in the opposite direction (+$.56/cwt with a t-value of 1.38). The lack of any significant t-values suggests that the cotton futures market is efficient following candlestick patterns. This finding does not support candlestick chartists claims' about the predictive value of candlestick patterns. The trading returns do not include a transactions cost, which would further decrease the calculated t-values in Table 1.

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 resulting statistical tests, 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 used to cut losses short and allow profits to run. This would eliminate some of the individual 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 it was consistent with the trading position of a moving average system. Separating individual patterns from the buy and sell groups used in this study might also prove useful. This would allow individual testing of candlestick patterns and determine if some have more predictive value than others.

There is certainly room for more research, but the system for analyzing candlestick patterns needs to be improved. The MetaStock computer program was adequate for locating the trends and patterns, but manually transferring dates 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.

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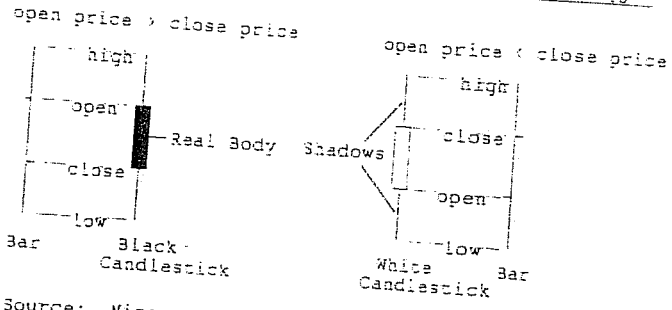
Table 1. Candlestick results for cotton futures, 1973-90.

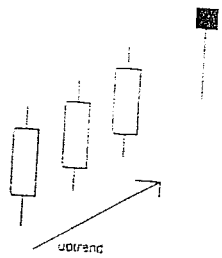
Trend, Trade Period, and Signal	Mean Return	t-value	No. of Trades
5-day trend:			
Price 3 days after:			
Buy signal	.20	.26	21
Sell signal	.23	.74	49
Price 7 days after:			
Buy signal	.81	1.00	19
Sell signal	-.48	-1.10	47
Price 14 days after:			
Buy signal	-.06	-.05	14
Sell signal	.45	.55	43
20-day trend:			
Price 3 days after:			
Buy signal	.47	.50	13
Sell signal	.56	1.38	44
Price 7 days after:			
Buy signal	1.17	1.53	13
Sell signal	-.34	-.51	42
Price 14 days after:			
Buy signal	.08	.13	11
Sell signal	.33	.30	40



Source: Nison, 1991b.

Figure 1. Bar and candlestick charts.

The hanging man occurs in an uptrend and consists of two criteria: 1) A real body at the upper end of the trading range with no upper shadow, and 2) a lower shadow that is at least twice as long as the real body (Nison, 1991a).



A hanging man indicates that the market is at or near its top and a downward movement of prices can be expected. A hanging man is shown in the March 1989 contract below.

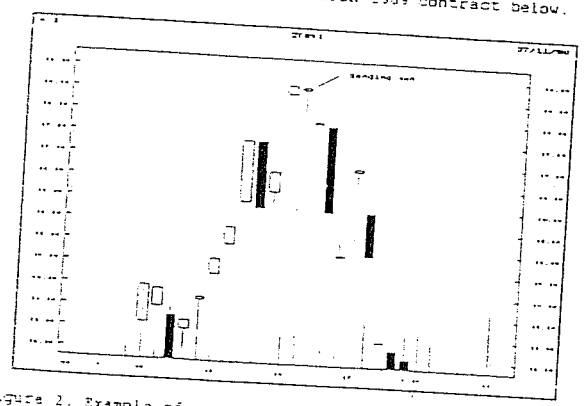
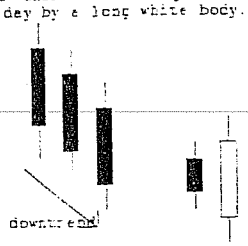


Figure 2. Example of a bearish hanging man.

Economics

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.

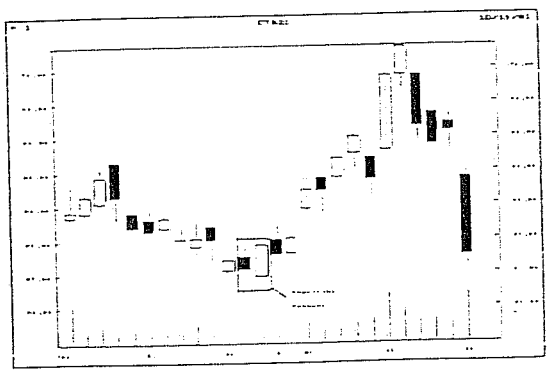


Figure 3. An example of a bullish engulfing pattern.

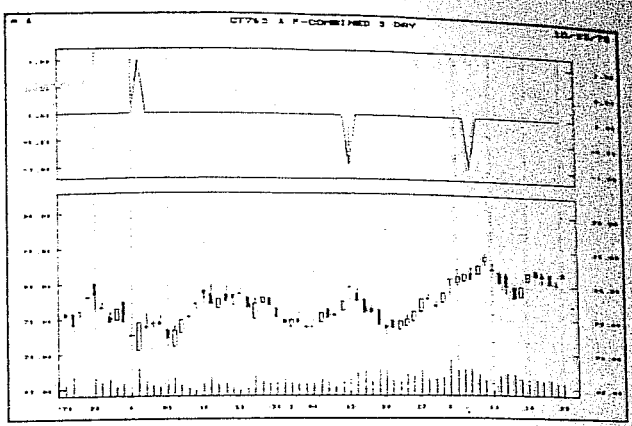


Figure 4. MetaStock candlestick and indicator charts.