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A comprehensive look at the predictive information in Japanese candlestick

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Abstract

This article takes a comprehensive look at the performance of Japanese Candlestick in forecasting equity returns. We find that Japanese Candlestick does provide predictive information in both in-sample (IS) and out-of-sample (OOS) forecasts; and there is significant information spillover from the U.S equity market to the other markets. The results obtained are instructive to traders and portfolio managers but challenging to academic claims.

Keywords:
Market Predictability, Japanese Candlestick, Upper and Lower Shadows

1. Introduction

Classical financial economics argues the efficiency of financial market in reflecting information and the unprofitability of charts. Although this argument is elegant and well-recognized, it seems that it is not well-accepted by traders just by taking a look at the various charts widely employed by traders to help read the markets minds.

Empirical investigations into the predictive power of technical indicators (also known as charts) are huge, while the results depends. For example, Cowles (1993), Fama and Blume

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(1966), and Jesen and Benington (1970) report little profitable performance for a variety of popular technical indicators; Lo, Mamaysky, and Wang (2000) find that several technical indicators based on automatic pattern recognition with kernel regressions have practical value; and more recently, Neely et al. (2010) report some technical indicators are closely related to the business cycle and informative in predicting the level of the market risk premium.

Different from the above mentioned empirical studies, we are interested in the forecasting ability of the Japanese Candlestick in a predictive regression framework. We seek to answer the questions that whether or not the Japanese Candlestick charts, which are clearly available to investors, are providing valuable information for forecasting the equity returns by taking a comprehensive look at the main global financial markets[2].

2. Econometric Methodology

2.1. Forecast Construction

Adhering to the conventional framework for analyzing equity return predictability and the suggestions of Xie and Wang (2011), we employ the following regression form:

$$r_{t+1} = \alpha + \sum_{i=1}^{m}\sum_{j=0}^{n}\beta_{i,j}x_{i,t-j} + \varepsilon_{t+1}, \tag{1}$$

where r_{t+1} is the return on a stock market index over period from time t to t+1, $x_{i,t-j}$ is a predictor of interest, and ε_{t+1} is a zero-mean disturbance term.

Conventionally, out-of-sample forecasts are generated in a dynamic way using an expanding or a rolling window due to the usual argument of the instability of data generation process. However, Xie and Wang (2011) find that the stability of Japanese Candlestick for making out-of-sample forecasts by using the static forecast procedure. To be specific, the total sample of T observations for r_t and $x_{i,t}$ are divided into two portions: the in-sample portion composed of the first m observations and the out-of-sample portion composed of the last n (n=T-m) observations. The first m observations are used to estimate the coefficients α and $\beta_{i,j}$

$$\hat{r}_{t+1} = \hat{\alpha} + \sum_{i=1}^{m}\sum_{j=0}^{n}\hat{\beta}_{i,j}x_{i,t-j}, \tag{2}$$

where $\hat{\alpha}$ and $\hat{\beta}_{i,j}$ are the ordinary least squares (OLS) estimates of α and $\beta_{i,j}$, respectively. When generating the static out-of-sample forecasts, the initial out-of-sample forecast of the stock return is given by

$$\hat{r}_{m+1} = \hat{\alpha} + \sum_{i=1}^{m}\sum_{j=0}^{n}\hat{\beta}_{i,j}x_{i,m-j}. \tag{3}$$

With the same $\hat{\alpha}$ and $\hat{\beta}_{i,j}$, the next out-of-sample forecast is reported by

$$\hat{r}_{m+2} = \hat{\alpha} + \sum_{i=1}^{m+1}\sum_{j=0}^{n}\hat{\beta}_{i,j}x_{i,m+1-j}. \tag{4}$$

[2]Xie and Wang (2011) take the first step investigating the Japanese Candlestick forecasting performance in the U.S stock market and find statistically and economically gains

Proceeding in this manner through the end of the out-of-sample period, we generate a series of n out-of-sample forecasts of the stock return. Static forecasts are structurally sensitive, any critical structural changes, say a sharp increase in the $\hat{\beta}_{i,j}$, will result in very poor out-of-sample forecasts.

In the present paper, the predictors of interest are the components of Japanese Candlestick: the upper and lower shadows. A typical Japanese Candlestick consists of two parts: real body and shadow. Depending on the closing price and opening price, Japanese Candlestick is classified as white candlestick and black candlestick. Figure 1 presents the charts of Japanese Candlestick.

We say a black candlestick appears if the opening price is over the closing price, otherwise, a white candlestick comes out. Correspondingly, the upper shadow and lower shadow are defined as:
If $C_t \geq O_t$,

$$\begin{aligned} US_t &= H_t - C_t, \\ LS_t &= O_t - L_t, \\ RB_t &= C_t - O_t, \end{aligned}$$

otherwise,

$$\begin{aligned} US_t &= H_t - O_t, \\ LS_t &= C_t - L_t, \\ RB_t &= O_t - C_t, \end{aligned}$$

where US_t, LS_t, RB_t are the upper shadow, lower shadow and real body, respectively. H_t, L_t, O_t and C_t are highest, lowest, opening and closing prices, respectively. Technical analysts believe the upper and lower shadows are predictive and frequently use them to predict the future market prices, see Nison (1991) and Morris (1992).

Instead of using the original Japanese Candlestick definitions, we employ the following definitions:
If $C_t \geq O_t$,

$$\begin{aligned} us_t &= log(H_t) - log(C_t), \\ ls_t &= log(O_t) - log(L_t), \end{aligned}$$

otherwise,

$$\begin{aligned} us_t &= log(H_t) - log(O_t), \\ ls_t &= log(C_t) - log(L_t). \end{aligned}$$

2.2. Forecast Evaluation

If forecasts do not capture any of the information contained in the real values, we would expect that the slope λ of the following regressions will be zero.

$$r_t = c + \lambda \hat{r}_t + \mu_t, \tag{5}$$

where r_t are the real stock returns and $\hat{r}_t$ the forecasts, μ is an i.i.d noisy series of mean zero. In case of statistically significant nonzero of λ, we conclude the forecasts are informative. Put it another way, predictive variables would generate informative forecasts. In case of $c = 0$ and $\lambda = 1$, $\hat{r}_t$ is said to be the unbiased forecasts of r_t.

3. Empirical Results

3.1. Data Collection and Construction

To make a comprehensive look at the performance of the Japanese Candlestick, we collect the monthly index data from the main open global financial markets: FTSE100, DAX, CAC40 in Europe; NIKKEI225 (NK), HangSeng (HS) and Strait Times (ST) in Asia. Xie and Wang (2011) have demonstrated that the Japanese Candlestick are informative in predicting the U.S stock market. We also collect the U.S stock market price information for a different purpose. We want to know whether or not the U.S Japanese Candlestick will spillover to the other financial markets given the U.S market plays a leading role. The monthly data we collect from the U.S market are the Standard and Poors 500 (S&P500) index data. For each month, four pieces of information, opening, highest, lowest and closing, are reported[3]. The data set is downloaded from the finance subdirectory of the website "www.finance.yahoo.com".

3.2. Regression Results

We perform both in-sample and out-of-sample forecasts. The in-sample forecasts span the whole sample observations. When performing out-of-sample forecasts, the whole sample observations are divided into two portions. The last eleven years' observations (2001.01-2011.08) are used as out-of-sample forecasting tests, and the prior observations are employed to estimate the coefficients.

Predictors $x_{i,t-j}$ employed in this paper are upper and lower shadows. The predictors are selected based on the following procedures: we first calculate the cross correlations between equity returns and shadows; shadows with the largest correlations and larger than 0.1 are used as predictors.

Table 1 presents the in-sample regression estimates[4]. Regression analysis demonstrates the informativeness of Japanese Candlestick in predicting stock returns. What is notable is that there is obvious information spillover from the U.S stock market to the remaining stock markets as the upper shadow us_{sp} is statistically significant. All of Adjusted R^2s are more than 1% indicating some kind of predictability of the stock returns. The high Adjusted R^2s of over 10% in DAX and ST hint the high predictability in these two markets. Figure 2 gives a glimpse of the in-sample forecasting results.

When performing out-of-sample regression estimates, the predictors are selected from the in-sample ones and the results are presented in Table 2. Although some predictors present in Table 1 disappear in Table 2, there does have some stable predictors appearing in both Tables 1 and 2. Notably, we find significant and stable information spillover from the U.S stock market to DAX, CAC40 and ST stock markets. Figure 3 plots the out-of-sample forecasts of DAX, CAC40, HK and ST. We don't report the out-of-sample forecasts of FTSE100 and NK for the consideration that Adjusted R^2=0. To some extent, Figure 3 demonstrates the out-of-sample

[3]The data we collect have significantly different time-spans: FTSE spans 1984.04-2011.08; DAX spans 1990.12-2011.08; CAC40 spans 1990.03-2011.08; NK spans 1984.01-2011.08; HS spans 1987.01-2011.08; ST spans 1988.01-2011.08.

[4]The notation $ls_x(us_x)$ denote the shadows calculated using data from market x, for example, if x represents FTSE100 then ls_x represents lower shadow calculated using FTSE100 index; we use $*$, $\circ$ to represent significance level: $***$ indicates significance at 1%, $**$ indicates significance at 5% and $*$ indicates significance at 10%, $\circ$ indicates no significance at 10% level; notation t-k indicates how many lags are used as predictors.

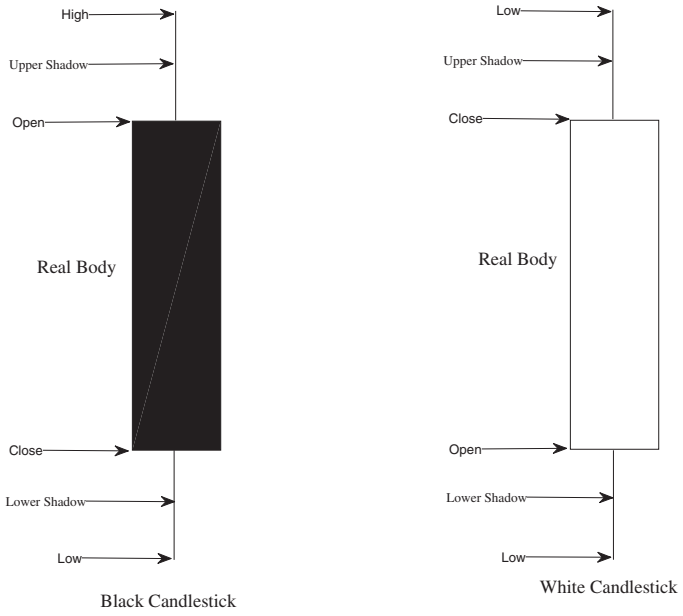

Figure 1. A Japanese Candlestick

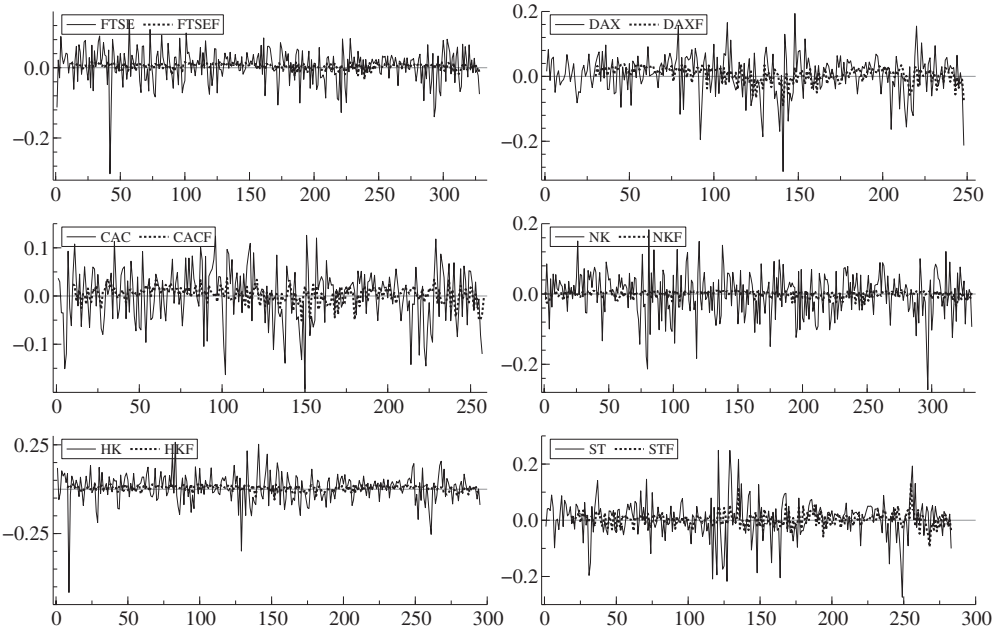

Figure 2. In-sample Forecasts

Table 1. In-sample regression estimates

r_t	α	ls_x	us_x	ls_{sp}	us_{sp}	$AdjusteR^2$
FTSE100	0.0165^{***}	$\cdots$	-0.319^{*}_{t-12}	$\cdots$	0.0165^{**}_{t-14}	0.026
DAX	0.0470^{***}	-0.286^{**}_{t-29}	-0.521^{**}_{t-30}	-0.438^{***}_{t-2}	-0.319^{***}_{t-14}	0.107
CAC40	0.0183^{**}	-0.288^{*}_{t-10}	0.464^{**}_{t-1}	-0.314^{**}_{t-32}	-0.819^{***}_{t-14}	0.0712
NK	0.0096^{*}	$\cdots$	$\cdots$	$\cdots$	-0.706^{***}_{t-18}	0.018
HS	0.0289^{***}	$\cdots$	-0.570^{**}_{t-8}	$\cdots$	-0.770^{***}_{t-14}	0.0282
ST	0.00305°	-0.382^{***}_{t-19}	0.870^{***}_{t-3}	0.349^{**}_{t-6}	-0.895^{***}_{t-14}	0.108

forecasts well capture the ups and downs of the actual stock returns. The forecast evaluation regression analysis is reported as follows:

$$\begin{aligned} DAX : r_t &= 0.00108^{\circ} + 0.553^{**}\hat{r}_t \\ CAC40 : r_t &= -0.00471^{\circ} + 0.642^{**}\hat{r}_t \\ HK : r_t &= -0.000178^{\circ} + 0.415^{\circ}\hat{r}_t \\ ST : r_t &= 0.00459^{\circ} + 0.386^{***}\hat{r}_t \end{aligned}$$

Although forecast evaluation results indicate biased out-of-sample forecasts, they do consolidate the conclusion that $\hat{r}_t$ are informative forecasts of r_t given that the slope of each regression is statistically significant at a level of 5%. $\hat{r}_t$ are informative forecasts of r_t can be further demonstrated by trading strategy. Suppose there are two assets, cash and stock. The forecast trading strategy is performed as follows: if out-of-sample forecasts are positive, we hold stock, otherwise we hold cash. The final wealth of buy-and-hold and forecast trading strategies are presented in Figure 4. In all of these four cases, the forecast trading strategy demonstrates its advantage over the simple buy-and-hold, confirming that $\hat{r}_t$ are informative forecasts of r_t.

Table 2. Out-of-sample regression estimates

r_t	α	ls_x	us_x	ls_{sp}	us_{sp}	$AdjusteR^2$
FTSE100	0.008493^{**}	$\cdots$	$\cdots$	$\cdots$	$\cdots$	0
DAX	0.0353^{***}	-0.638^{**}_{t-29}	$\cdots$	$\cdots$	-0.897^{*}_{t-14}	0.05
CAC40	0.0263^{***}	$\cdots$	$\cdots$	-0.495^{*}_{t-32}	-0.782^{*}_{t-14}	0.034
NK	0.00149°	$\cdots$	$\cdots$	$\cdots$	$\cdots$	0
HS	0.0246^{**}	$\cdots$	-0.813^{**}_{t-8}	$\cdots$	$\cdots$	0.0215
ST	0.000618°	-0.422^{*}_{t-19}	1.593^{***}_{t-3}	$\cdots$	-1.580^{***}_{t-14}	0.139

4. Conclusions

This paper takes a comprehensive look at the predictive information contained in the Japanese Candlestick. Both in-sample and out-of-sample forecasts indicate informativeness of the Japanese Candlestick in forecasting stock returns. Also we find the leading role of the U.S stock market

in the global financial markets. Our findings are valuable to not only portfolio management but also risk management and challenging to the argument of market efficiency.

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References

[1] Cowles, A.: "Can Stock Market Forecasters?" *Econometrica*, 1 (1993), 309-324.
[2] Fama, E. F., and Blume, M. E.,: "Filter Rules and Stock Market Trading," *Journal of Business*, 39 (1966), 226-241.
[3] Jesen, M. C., and Benington, G. A.: "Random Walks and Technical Theories: Some Additional Evidence" *Journal of Finance*, 51 (1970), 469-482.
[4] Lo, A. W., Mamaysky, H., and Wang, J.: "Foundations of Technical Analysis: Computational Algorithms, Statistical Inference, and Empirical Implementation" *Journal of Finance*, 55 (2000), 1705-1765.
[5] Neely, C. J., Rapach, D. E., Tu, J., and Zhou, G: "Forecasting the Equity Risk Premium: The Role of Technical Indicators", Working Paper, 2010, available at http://research.stlouisfed.org/wp/2010/2010-008.pdf.
[6] Morris, G.: *Candlestick Charting Explained*. New York (1992), McGraw-Hill.
[7] Nison, S.: *Japanese Candlestick Charting Techniques*. New York Institute of Finance (1991), New York.

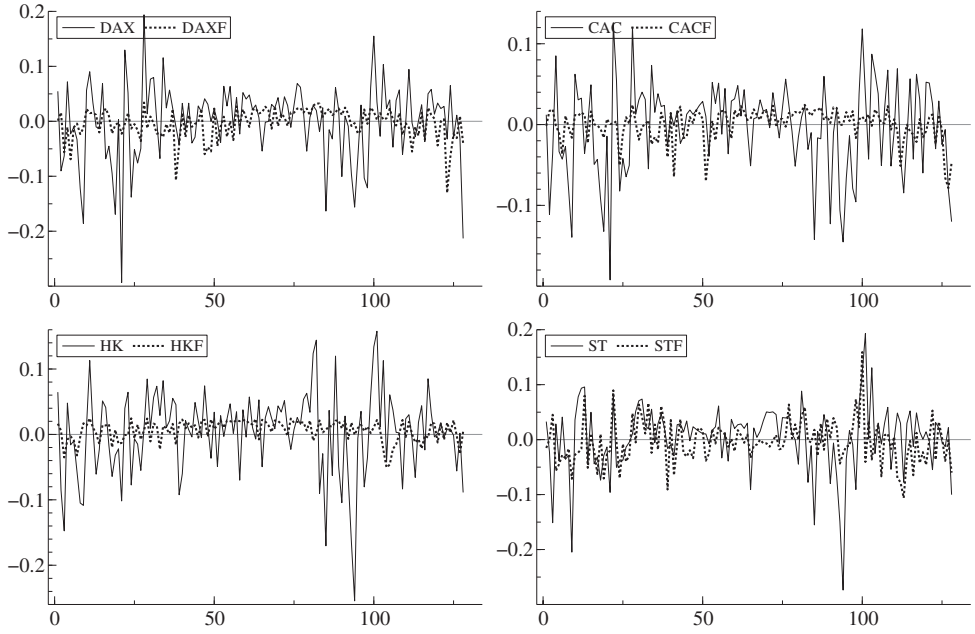

Figure 3. Out-of-sample Forecasts

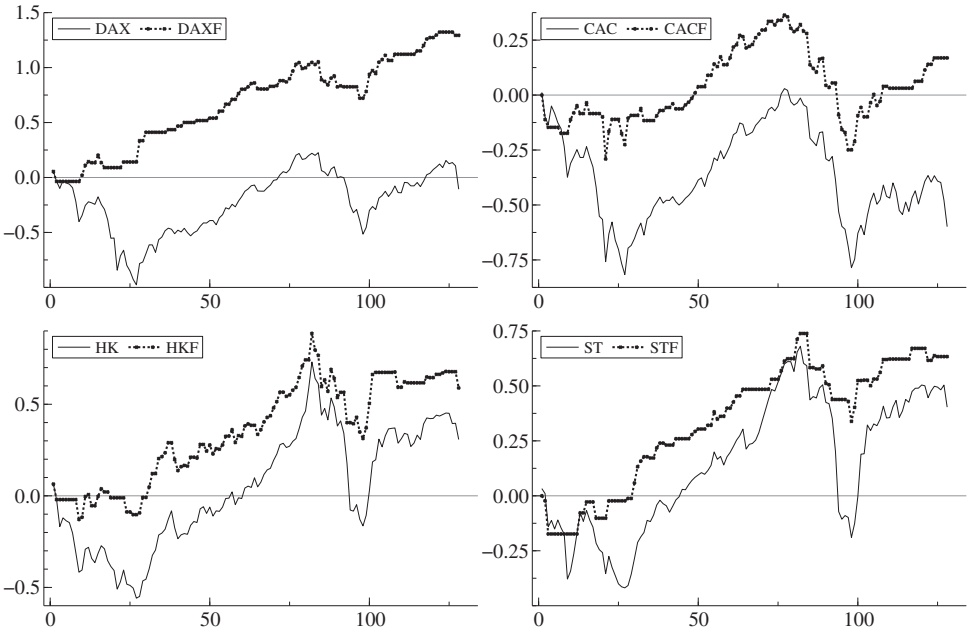

Figure 4. Out-of-sample Forecasts trading strategy: buy-and-hold vs. forecast