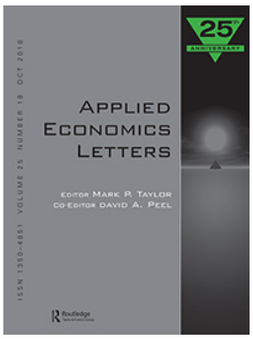

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Technical analysis and the London stock exchange: testing the MACD and RSI rules using the FT30

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This article examines two oscillators – the Moving Average Convergence–Divergence (MACD) and the Relative Strength Index (RSI) – to see if these rules are profitable. Using 60-year data of the London Stock Exchange FT30 Index, it is found that the RSI as well as the MACD rules can generate returns higher than the buy-and-hold strategy in most cases.

I. Introduction

Technical analysis studies the historical price patterns or trends or any other clues that are indicative of future price movements. It has been increasingly popular over recent years, among the financial practitioners, to make investment decisions (Taylor and Allen, 1992; Neely, 1997). Whether technical trading rules can generate excess returns has long been a controversial issue. If they do help investors to earn higher returns, it implies that the efficient market hypothesis (EMH), which states that security prices at any time fully reflect all available information, does not hold. A number of studies have been carried out to examine the performance of various trading rules. Fama (1965) found that the study of historical prices cannot predict future prices. Neftçi (1991) showed that when economic time series are assumed to be Gaussian, market indicators cannot help to predict future prices. When prices are nonlinear, technical trading rules can show some predictability. Hudson *et al*. (1996) demonstrated that moving averages and trading range breakout rules are not better than the buy-and-hold strategy under a costly trading environment.

Although these studies are not in favour of technical trading rules, there are also findings showing the opposite. Treynor and Ferguson (1985) argued that when the nonprice information is taken into account, historical prices can help to generate higher returns. Brock *et al*. (1992) tested the moving average and trading range breakout rules on the Dow–Jones Industrial Average and concluded that these two rules outperform the buy-and-hold strategy. Mills (1997) showed a similar result for the FT30 index. Kwon and Kish (2002) documented that the technical rules beat the buy-and-hold strategy in the NYSE. In this article, two oscillators will be evaluated to see if their associated rules are profitable when compared with the buy-and-hold strategy. The data set of Mills (1997) will be reexamined.

II. Data and Trading Rules

Data

The data series under study is the Financial Times – Institute of Actuaries 30 (FT30) index of Mills (1997). It is the longest UK index and the sample period is from July 1935 to January 1994. To avoid the problem of data snooping, we split the whole sample into three fairly long subsamples, namely

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1935–1954, 1955–1974 and 1975–1994. Each subsample contains about 5000 observations. Daily closing prices within this period are adopted for analysis.

Trading rules

The oscillators examined in this article are the Relative Strength Index (RSI) and the Moving Average Convergence–Divergence (MACD). The RSI is a widely used oscillator defined as:

$$\mathrm{RSI}_t(n) = \frac{\sum_{i=0}^{n-1} (P_{t-i} - P_{t-i-1}) 1\{P_{t-i} > P_{t-i-1}\}}{\sum_{i=0}^{n-1} |P_{t-i} - P_{t-i-1}|} \times 100 \tag{1}$$

where RSI_t is Relative Strength Index at time t, P_t is the value of index at time t, n is the number of RSI periods, $1\{\cdot\}$ is an indicator function which equals one when the statement inside the bracket is true and equals zero otherwise, $|x|$ is the absolute value of x. The RSI ranges from 0 to 100. A stock is considered overbought when its RSI is above 70, while it is regarded as oversold when the RSI is below 30. When the RSI is above 50, it indicates a bullish signal, while the security is considered bearish when the RSI is below 50.

In this article, the 14-day RSI, a popular length utilized by traders, will be studied. To implement the trading rule, a buy signal is triggered when the RSI crosses the centre line from below, while a sell signal is triggered when the RSI crosses the centre line from above.

The MACD is constructed based on the moving averages. It is calculated by subtracting the longer exponential moving average (EMA) from the shorter EMA. The EMA is defined as:

$$\mathrm{EMA}_t = \left[\frac{2}{n} \times (P_t - \mathrm{EMA}_{t-1})\right] + \mathrm{EMA}_{t-1} \tag{2}$$

where EMA_t is the exponential moving average at time t, n is the number of periods for EMA. The initial EMA is the n-day simple moving average of the series. In this article, we focus our attention on the 12 and 26-day EMAs, which are the most commonly used short and long-period EMAs (Murphy, 1999). A buy signal is triggered when the MACD crosses the zero line from below, while a sell signal is triggered when the MACD crosses the zero line from above.

Following the practice of Brock *et al.* (1992), we focus on the 10-day returns, which is defined as

$$\text{10-day return } (r_t^{10}) = \log(P_{t+10}) - \log(P_t) \tag{3}$$

where P_t is the closing price on day t. Note that a negative return generated by the sell signal implies a positive profit. Whenever there is a buy/sell signal, all other signals during the next 10 days are ignored. We will apply the earlier method throughout this article.

III. Empirical Results

Sample statistics

Table 1 reports descriptive characteristics for 10-day returns of FT30.

$\rho(i)$ is the estimated autocorrelation at lag i for each series. The mean value of the 10-day return is 0.22%, which is about 5.8% annually. It is also the return of the buy-and-hold strategy for the whole sample period. The series shows a high degree of autocorrelation. All the five autocorrelations are highly significant and are greater than 0.5. Results for subperiods are analogous. All the five autocorrelations are in the range of 0.5–0.9 and are significant at the 5% level. The index is also strongly leptokurtic in the whole period sample as well as in all subsamples. The returns in all periods are negatively skewed, except the subperiod 1975–1994.

Table 1. Summary statistics for 10-day returns

Period	Whole period	1935–1954	1955–1974	1975–1994
Mean	0.00219	0.00123	0.00017	0.00518
SD	0.03536	0.02711	0.03374	0.04320
Skewness	−0.22718**	−0.99427**	−0.52513**	0.02679**
Kurtosis	11.74120**	8.45212**	4.98334**	12.55735**
$\rho(1)$	0.92400**	0.95099**	0.91136**	0.92046**
$\rho(2)$	0.83690**	0.77074**	0.81091**	0.83849**
$\rho(3)$	0.74786**	0.86993**	0.71764**	0.75539**
$\rho(4)$	0.65697**	0.66506**	0.62941**	0.66806**
$\rho(5)$	0.56548**	0.56117**	0.54617**	0.57575**

Note: The numbers marked with ** are significant at the 5% level for a two-tailed test.

Trading rules

Tables 2 and 3 display the 10-day returns and the corresponding *t*-statistics of the two oscillators. Following the notations in Brock *et al*. (1992), we define

$$t\text{-statistic for buys (sells)} = \frac{\mu_r - \mu}{\sqrt{\sigma^2/N + \sigma^2/N_r}} \quad (4)$$

where μ_r and N_r are the mean return and number of signals for the buys or sells and μ and N are the unconditional mean and number of observations. σ^2 is the estimated variance for the entire sample. For the buy-sell, we define

$$t\text{-statistic for buy} - \text{sell} = \frac{\mu_b - \mu_s}{\sqrt{\sigma^2/N_b + \sigma^2/N_s}} \quad (5)$$

where μ_b and N_b are the mean return and number of signals for the buys and μ_s and N_s are the mean return and number of signals for the sells.

The results of the RSI are summarized in Table 2.

The column 'Buy' refers to the average 10-day returns generated by the buy signals, while numbers in the 'Sell' column are average 10-day returns generated by sell signals. For the RSI, a buy signal on average generates a 10-day return of 0.779% for the full sample (or an annual return of 22.44%), whereas a sell signal generates a return of about −0.127% (or −3.36% annually). The buy return is significantly different from the unconditional mean returns of 0.2192% at the 5% level, while the sell return is significant at the 10% level.

The fractions of buy signals and sell signals that have positive returns are reported in the columns 'Buy > 0' and 'Sell > 0' respectively. The last column is the 10-day returns from a pair of buy and sell signals, which is the difference between the 'buy' returns and the 'sell' returns.

Among the three subperiods, 1975–1994 generates the highest number of significant returns. The buy return is significant at the 10% level while the buy-sell return is significant at the 5% level. In the subperiod 1935–1954, only the buy-sell return is significant at the 10% level, the other two returns are insignificant. Returns in the subperiod 1955–1974 are all insignificant. Therefore, the use of RSI in this period is less profitable when compared to the buy-and-hold strategy, which generates a 10-day return of 0.017%.

Since there are 4.9 buy signals and 5.2 sell signals per year on average, investors can earn an annual return of 4.48% ($4.9 \times 0.779\% + 5.2 \times 0.127\%$) annually.

Table 3 shows the results of the MACD rule.

The MACD rule also shows sign of predictability. The buy and sell returns for the whole sample are highly significant at the 5% level. It is noteworthy that the fraction of 'Buy > 0' always exceeds that of 'Sell > 0'. The average 10-day return (annual return) for the buy signal is 1.375% (42.9%), while it is −0.679% (−19.3%) for the sell signal. On average, there are 2.7 buy signals and 3 sell signals per year, an investor who follows this rule can gain an annual return of 5.75% ($0.679\% \times 3 + 1.375\% \times 2.7$).

The results of the subsamples are highly consistent with those of the whole sample. It is found that except

Table 2. The returns of the RSI rule

	N(Buy)	*N*(Sell)	Buy		Sell		Buy > 0	Sell > 0	Buy–Sell	
Whole period	296	311	0.00779**	(2.696)	−0.00127*	(−1.709)	0.622	0.495	0.00906**	(3.154)
Subperiod										
1935–1954	86	88	0.00466	(1.161)	−0.00305	(−1.469)	0.651	0.432	0.00771*	(1.874)
1955–1974	109	106	0.00481	(1.424)	−0.00160	(−0.533)	0.587	0.500	0.00641	(1.394)
1975–1994	101	117	0.01367*	(1.954)	0.00036	(−1.192)	0.634	0.538	0.01330**	(2.267)

Notes: The numbers marked with ** and * are significant at 5 and 10% for a two-tailed test.
The figures inside the brackets are the *t*-statistics.

Table 3. The returns of the MACD rule

	N(Buy)	*N*(Sell)	Buy		Sell		Buy > 0	Sell > 0	Buy–Sell	
Whole Period	160	181	0.01375**	(4.111)	−0.00679**	(−3.395)	0.706	0.459	0.02053**	(5.351)
Subperiod										
1935–1954	48	54	0.01418**	(3.294)	−0.01054**	(−3.175)	0.833	0.407	0.02472**	(4.598)
1955–1974	54	59	0.00982**	(2.093)	−0.00236	(−0.572)	0.630	0.492	0.01218*	(1.918)
1975–1994	58	68	0.01704**	(2.079)	−0.00765**	(−2.432)	0.672	0.471	0.02469**	(3.197)

Note: The numbers marked with ** and * are significant at 5 and 10% for a two-tailed test.

the sell return in 1955–1974, all buy, sell and buy–sell returns are significant at the 5 or 10% level.

To conclude, we find that the RSI rule and the MACD rule outperform the buy-and-hold strategy. Such a conclusion is, in general, robust to the choice of the sample period.

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