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A note on the weak form efficiency of capital markets: The application of simple technical trading rules to UK stock prices – 1935 to 1994

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Abstract

Brock et al. (1992) found technical trading rules to have predictive ability with regards to the Dow Jones Index. The current paper considers whether this result can be replicated on UK data. The paper also considers whether investors could earn excess returns from technical analysis in a costly trading environment. The paper concludes that although the technical trading rules examined do have predictive ability in terms of UK data, their use would not allow investors to make excess returns in the presence of costly trading.

JEL classification: G14

Keywords: Efficiency; Capital markets; Technical rules

1. Introduction

Brock et al. (1992) found simple technical trading rules to have predictive ability in terms of the Dow Jones Index over the period 1897 to 1986. The present paper considers if their result is replicable on UK data and, furthermore, whether investors could earn excess returns in the presence of costly trading. The paper has the following structure. The first section briefly describes the data and the

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technical trading rules. The second section examines the predictive ability of the technical trading rules on UK data. The third section considers whether the trading rules could earn excess returns in the presence of costly trading and the final section offers conclusions.

2. Data and technical trading rules

2.1. Data

In their examination of the predictive ability of technical trading rules Brock et al. (1992) utilised the Dow Jones index from the first trading day of 1897 to the last trading day of 1986. The present study uses the Financial Times Industrial Ordinary Index, which is the longest daily series available in the UK, from July 1935 to January 1994. The index is calculated on the stock prices of 30 UK companies which cover a wide range of British manufacturing and service industries (Appendix A contains a list of the companies comprising the index at the end of 1994). The index is calculated by an adjustment based method using the price movements since the previous day's closing index to generate the form:

$$\mathrm{FT30}_t = \mathrm{FT30}_{t-1} \sqrt[30]{\frac{S_{t,1}}{S_{t-1,1}} \times \frac{S_{t,2}}{S_{t-1,2}} \times \cdots \frac{S_{t,30}}{S_{t-1,30}}}$$

where $\mathrm{FT30}_t$ is the index at time t and $S_{t,1}$ is the stock price of company 1 at time t. For the FT30 index the size of a company is not of prime importance, rather a key consideration is that the stocks are actively traded and the company is a leader in its own field without any undue influence on the stock price from overseas. To reflect possible changes in the economic and political environment, the overall sample period is broken down into the following sub-periods; 1935–51 to reflect the war years, 1951–66 to capture the post-war economic boom, 1966–81 to reflect the period of economic and political uncertainty in the UK and, finally, 1981 to 1994 to reflect the impact of 'Thatcher' policies on the UK.

2.2. Technical trading rules

Replicating the analysis of Brock et al. (1992), two of the simplest and most popular classes of technical trading rules, *moving average* rules and *trading-range breakout* rules, are examined here. With moving average rules, buy and sell signals are generated by comparing short run moving averages with long run moving averages. For example, Brock et al.'s variable moving average (VMA) rule,

"initiates buy (sell) signals when the short run moving average is above (below) the long run moving average" (pp. 1735–1736).

Whereas the fixed moving average (FMA) rule emphasises the short run moving average crossing the long run moving average,

"a buy (sell) signal is generated when the short run moving average cuts the long moving average from below (above)" (p. 1736).

For both of these rules it is possible to produce variants by defining the short and long run moving averages across time periods of different lengths and by introducing a band width around the long run moving average. For example, if a 1% band width is introduced to a moving average rule, a buy signal is only produced when the short run moving average is at least 1% above the long run moving average. Brock et al. consider the rules with and without 1% band widths.

In contrast to the moving average rules, the trading-range breakout (TRB) rule triggers a sell (buy) signal if the stock price moves below (above) a 'support' (resistance) level defined as the minimum (maximum) price achieved by the stock over a previous period. As for the moving average rules, it is possible to produce variants by defining the support and resistance levels over different period lengths and by introducing band widths around these levels.

3. Empirical results

3.1. Sample statistics

Table 1 contains summary statistics for one-day returns for the entire series and the four sub-periods. The returns are calculated as log differences of the level of the index. Although it is not possible to directly compare the mean and standard deviation of the returns of this study with those of Brock et al. (1992) because of the differing sample periods, they are of approximately the same order of magnitude. Similarly, the present distributions also show signs of skewness and of being strongly leptokurtic. Although Brock et al. also offered summary statistics for ten-day returns, they are not reported here as they add little to the present discussion. The serial correlations approximate those of Brock et al. and are generally small with the exception of the one-period lag for the earliest two sub-samples. In general, therefore, the present data set is remarkably similar in its basic form to that used by Brock et al.

3.2. Moving-average rules

Although Brock et al. (1992) used bootstrap techniques to explore the stochastic properties of stock returns, standard statistical tests are sufficient for the purposes of the present paper. Results from trading strategies based on variable moving average (VMA) rules for the full sample are presented in panel A of Table

Table 1
Descriptive statistics for daily returns

Statistic	Full sample	1/7/35–31/5/51	1/6/51–19/7/66	20/7/66–4/11/81	5/11/81–31/1/94
N	14802	3853	3860	3902	3187
Mean	0.000264	0.000070	0.000254	0.000208	0.000579
Std. dev.	0.0100498	0.0062449	0.0072111	0.0142828	0.0105356
Skew	0.021725	−0.20810 **	−0.19333 **	0.307932 **	−0.59228 **
Kurt	14.56325 **	22.52505 **	9.982940 **	8.292418 **	13.32761 **
ρ(1)	0.097949	0.336608	0.254663	0.047741	0.017707
ρ(2)	0.013865	0.191725	0.032672	−0.02339	0.013548
ρ(3)	0.012738	0.049181	−0.045960	0.022978	0.006524
ρ(4)	0.014297	0.002708	−0.032830	0.014662	0.043442
ρ(5)	0.012436	0.025780	−0.013070	0.017175	0.009475

ρ(·) denotes autocorrelation for lag (*n*) days.
** Significant at 1% level for a two-tailed test.

Table 2
Standard test results for the variable length moving average (VMA) rules

Panel A. *Full sample*

Test	*N*(Buy)	*N*(Sell)	Buy	Sell	Buy − sell
(1,50,0)	8735	6067	0.000713	−0.000382	0.001095
			(3.29518) *	(−4.1990) *	(6.490357)
(1,150,0)	9138	5664	0.000491	−0.000053	0.000544
			(1.55071)	(−2.1303) *	(3.18809)
(1,200,0)	9296	5506	0.000484	−0.000107	0.000591
			(1.64582)	(−2.3295) *	(3.44314)
(5,150,0)	9137	5665	0.000423	0.000008	0.000415
			(1.18446)	(1.6269)	(2.43486)
(1,50,0.01)	7182	4749	−0.000774	−0.000510	0.001284
			(−3.53581) *	(−4.61534) *	(6.834008)
Average			0.000577	−0.00021	0.000786

Panel B. *Sub-period results for (1,50,0) variant*

Period	*N*(Buy)	*N*(Sell)	Buy	Sell	Buy − sell
1935–51	2292	1561	0.000536	−0.000614	0.00115
			(2.82418) *	(−3.64586) *	(5.603404)
1951–66	2346	1514	0.000717	−0.000462	0.001179
			(2.43508) *	(−3.25740) *	(4.930111)
1966–81	2013	1889	0.000884	−.000513	0.001397
			(1.724492)	(−1.79915)	(3.051564)
1981–94	2084	1103	0.000737	0.000281	0.000456
			(0.530209)	(0.80784)	(1.159060)

* Significant at the 5% confidence level.

2. Column one of the panel refers to the different forms of the rule defined by the length of the 'short' and 'long' moving average periods and by the percentage (or 'band') by which a short run moving average must be above or below a long run moving average before buy/sell signals are triggered. For example, the (1,50,0) rule refers to the situation where the short run moving average is defined over one day, the long run moving average over 50 days and the percentage band width is zero percent. Columns 2 and 3 respectively refer to the number of buy and sell signals for the differing rules. Columns 4 and 5 are the mean daily returns during buy and sell periods with corresponding *t*-statistics (in parentheses below) testing equality with the unconditional mean return on a buy and hold strategy. The last column indicates the differences between the mean daily buy and sell returns.

Consistent with a rising market Table 2 reports that the number of buy signals exceeds the number of sell signals by approximately 50% for each of the trading rules. The buy returns are all positive with an average one-day return of 0.058%, which is approximately 16% at an annual rate. All the sell returns are negative with an average one-day return of −0.021%, which is approximately −6% at an

annual rate. These returns compare with a mean one-day return of 0.0264% (or approximately 7% at an annual rate) from holding the index unconditionally throughout the sample period 1935–1994 (see Table 1). For the ten tests of significance across the buy and sell decisions in Panel A of Table 2, six are significant at the 5% confidence level for a two tailed test and reject the null hypothesis that the returns to be gained from VMA rules are equal to those from a buy and hold strategy. However, there are twice as many significant negative returns from the sell signals than is the case for the positive returns from the buy signals.

Thus, although the returns from the VMA rules are significantly different from a buy and hold strategy and hence offer degrees of predictive ability, the majority of the significantly different returns are negative. Thus a question is raised over the sustainability of any individual technical trading rule as a profitable investment strategy.

To further replicate Brock et al., the VMA rules were analysed over the sub-periods defined above. In line with the results of Brock et al. (although they do not discuss the findings in any great detail) the present results lose some of

Table 3
Standard test results for the fixed length moving average (FMA) rules

Panel A. *Full sample*

Test	*N*(Buy)	*N*(Sell)	Buy	Sell	Buy − sell
(1,50,0)	167	193	0.014772	−0.006206	0.020978
			(4.63032) *	(−3.6441) *	(6.22213)
(1,150,0)	95	100	0.008298	−0.007621	0.015919
			(1.67296)	(−3.1327) *	(3.49512)
(1,200,0)	78	81	0.010524	−0.007173	0.017697
			(2.12209) *	(−2.7121) *	(3.56487)
(5,150,0)	86	86	0.007564	−0.007996	0.015560
			(1.38979)	(−3.0252) *	(3.21132)
(1,50,0.01)	253	198	0.00827	−0.002912	0.011182
			(2.590117) *	(−2.30091) *	(3.699236)
Average			0.0098856	−0.0063424	0.0162672

Panel B. *Sub-periods*

Period	*N*(Buy)	*N*(Sell)	Buy	Sell	Buy − sell
1935–51	41	45	0.006284	−0.013227	0.019511
			(1.716022)	(−4.50199) *	(4.590673)
1951–66	41	45	0.007749	−0.000979	0.008728
			(1.383524)	(−0.97973)	(1.767423)
1966–81	45	53	0.027212	−0.007239	0.034451
			(3.488435) *	(−1.41289)	(3.729671)
1981–94	40	50	0.016678	−0.003497	0.020175
			(1.926106)	(−1.83347)	(2.837770)

* Significant at the 5% confidence level.

their significance when the sample is split into sub-periods. Panel B of Table 2 reports results for the (1,50,0) VMA rule; the other rules offering similar results. It is clear from Panel B that the returns to buy and sell signals are still respectively positive and negative in nature but they are only significantly different from buy and hold returns for the first two sub-periods (1935–51 and 1951–66). In fact, the results generally lose significance as the sub-periods approach the present. Interestingly, none of the sub-period results reported by Brock et al. were significant. These sub-period results for both studies suggest that long periods (at least 15 to 20 years plus, depending on the index) may now be needed before the examined technical trading rules can be shown to have significant predictive content. If the conclusions regarding the length of time that might be needed for the VMA rules to have predictive content are added to the finding that a major part of the predictive content of the VMA rules only offers negative returns, then further doubts are raised concerning their sustainability as an investment tool.

Results for the fixed length moving average (FMA) rules (where buy/sell signals are generated by the crossing of short and long run moving averages and the returns are computed as cumulative over a ten-day post signal holding period) are presented in Table 3. The average return over the 10 days following a buy

Table 4
Standard test results for the trading range breakout (TRB) rules

Panel A. *Full sample*

Test	*N*(Buy)	*N*(Sell)	Buy	Sell	Buy − sell
(1,50,0)	408	237	0.00757	−0.00509	0.01266
			(2.75886) *	(−3.4886) *	(4.87048)
(1,150,0)	269	105	0.005953	−0.004696	0.010649
			(1.56569)	(−2.2887) *	(2.910500)
(1,200,0)	244	90	0.00717	−0.00589	0.01306
			(2.05157) *	(−2.4778) *	(3.33063)
(1,50,0.01)	160	151	0.00718	−0.001311	0.008491
			(1.708122)	(−1.45532)	(2.348700)
Average			0.006968	−0.004250	0.011215

Panel B. *Sub-periods*

Period	*N*(Buy)	*N*(Sell)	Buy	Sell	Buy − sell
1935–51	100	58	0.007903	−0.013637	0.02154
			(3.237699) *	(−5.18477) *	(6.625909)
1951–66	116	63	0.007957	−0.002307	0.010264
			(2.232024) *	(1.56477)	(2.868658)
1966–81	97	75	0.003479	−0.003404	0.006883
			(0.271983)	(−0.96384)	(0.991014)
1981–94	95	41	0.010914	−0.000348	0.011262
			(1.302195)	(−1.11039)	(1.800546)

* Significant at the 5% level.

signal is 0.99% and the average return over the 10 days following a sell signal is −0.63%. These returns compare with an average ten-day holding period return of 0.26%. The sell returns are negative and all are significant at the 5% level. In contrast, only three of the five positive returns from the buy signals are statistically significant at the 5% level for a two-tailed test. The sub-period results for the FMA rule are largely insignificant at the 5% level with only one sell and one buy signal significant at this level.

3.3. Trading-range breakout rules

Trading-range breakout (TRB) rules generate buy and sell signals when the price level moves above or below locally defined maxima and minima. Following Brock et al. (1992), the local maxima and minima were defined over 50-, 150- and 200-day periods and the rules considered the inclusion of a 1% band around the maxima and minima. To further replicate the framework of analysis adopted by Brock et al., the TRB rules were tested with the imposition of a ten-day holding period return. Results from the TRB rules with a ten-day holding period are presented in Table 4.

The average return over the 10 days following a buy signal is 0.7% and the average return over the 10 days following a sell signal is −0.43%. The number of significant returns under this heading approximately equals those achieved by the moving average rules. Furthermore, the current results obtained from the sub-period analysis generally replicate those achieved for the moving average rules, with less than half of the returns being significant at the 5% level.

4. Technical trading rules and weak form efficiency

The results reported above largely replicate those achieved by Brock et al. (1992) and lead to the following general conclusions: the technical trading rules examined have predictive ability; buy signals offer positive returns, whereas sell signals offer negative returns; the sell signals emanating from the rules have been shown to have greater predictive ability than the buy signals; and long periods are likely to be needed for the rules to display predictive ability. Brock et al. chose to follow up their initial analysis of the predictive ability of the technical trading rules with a bootstrap methodology. In concentrating on the nature of the predictability of stock returns, Brock et al. chose not to closely examine whether technical trading rules could be profitably used in a *costly* trading environment. In contrast, the present paper examines whether predictive ability could be put to profitable use in a costly trading environment. Hence, the current paper is directly concerned with the weak form efficiency of technical trading rules rather than the distributional properties of stock returns.

The profits that can be derived from the trading rules depend, among other

things, on the number of signals generated. Whether such profits are sufficient to cover trading costs, however, must depend directly on the profit generated *per round trip transaction* as triggered by the rules. Taking the suggested analysis of Brock et al., the following strategy is used to assess the profitability of the technical trading rules: upon a buy signal, the investor borrows so as to double the investment in the index; whereas, upon a sell signal, the investor sells and invests in a risk-free asset. If the number of buy and sell signals is approximately similar, the risk exposure of employing the strategy is assumed to approximate the risk of a buy and hold strategy so that the two strategies should produce similar returns. On this basis the profitability of the trading rules is considered.

For the VMA rules, (1,50,0), (1,150,0), (1,200,0), (5,150,0), each day is either a buy or a hold. However, the number of 'switches' requiring transaction costs is obviously much less; for each of the above rules, the average holding period was approximately 20, 38, 45, 52 days, respectively. As is consistent with a rising market, the number of buy signals exceeds the number of sell signals for each rule (columns 2 and 3 in Panel A of Table 2). However, by synthetically restricting the investor to an equal number of buy and sell positions the risk exposure approximates that of a buy and hold strategy. The average one-day buy and sell returns are given in columns 4 and 5 in Panel A of Table 2, with column 6 providing the sum of these returns on the basis that the Sell returns are positively assigned. Thus, for example, the final number in Panel A of Table 2 (0.000786) indicates an average one-day return (buy or sell) of 0.039%. Taking account of the average holding period for each strategy, the average return per round trip transaction (buy or sell) is approximately 1.13%. Thus because of leverage the *gain* is approximately 1.13% per round trip transaction over and above the return following a buy and hold strategy. If the investor had been allowed to take advantage of the total number of buy (and sell) signals and not restricted to an equal number of each, the average return per transaction would have risen to 1.33% with an associated increase in risk.

For the FMA rules, the number of buy signals is similar to the number of sells (Panel A, Table 3). The return over a pair of buy and sell signals is provided in the final column in Panel A of Table 3. The average return per transaction (buy or sell) is approximately 0.80%.

For the TRB rules, the number of buy signals again exceeds the number of sell signals (Panel A, Table 4). If (as for the VMA rules) the investor is restricted to an equal number of buy and sell positions, the average return per transaction (buy or sell) is approximately 0.56%. Whereas, if the investor is allowed to make use of all signals, the average return is slightly higher at approximately 0.60%.

Averaging across *all* the rules over the period, an average extra return per round trip transaction is estimated to be approximately 0.8%. Brock et al., using the (1,50,0.01) VMA rule as an example, calculate an extra return per transaction of approximately 0.49%. Brock et al. regard such benefits to be substantial. Set against a consideration of transaction costs, however, the benefits are somewhat

less impressive. Individual investors within the UK face quoted stockbroking buy and sell commissions of between 0.5–1.5%, UK Government stamp duty on purchase of 0.5% and bid–offer spreads in the range 1–5% [as observed across the literature of stockbrokers (members of the London Stock Exchange); for example, see the literature of BWD Rensburg (1995)] and, therefore, clearly cannot expect to benefit from the implementation of technical trading rules. The situation regarding large investing institutions is somewhat more complicated because of the largely negotiated nature of the majority of the transaction costs. However, from the authors' interviews with stockbrokers and stockbroking divisions of major clearing banks, [1] it is apparent that investing institutions may achieve negotiated brokering commissions as low as 0.1% ('soft' commissions may actually be zero if 'good will' is being actively sought or alternative services are offered in lieu of cash) and market maker bid–offer spreads as low as 0.5%. Given these costs and a liability for Government stamp duty of 0.5%, the total costs for even the most favoured of investors can be expected to be upward of 1% per round trip transaction and hence, greater than the average extra return per round trip transaction of 0.8% from the application of technical trading rules.

Thus, the above results contradict the efficient market hypothesis only in the absence of actual trading costs. In fact, the present findings tend to support the early analyses of technical trading rules (see Alexander, 1961, 1964; Fama and Blume, 1966). For example, Alexander (1961, 1964)) after reporting extensive tests of technical trading rules using daily data on price indices from 1897 to 1959 – while emphasising both that his data was inconsistent with the random walk hypothesis and that all the technical trading rules that he considered would have made a profit prior to transaction costs – nonetheless concluded,

"In fact, at this point I should advise any reader who is interested only in practical results, and who is not a floor trader and so must pay commissions, to turn to other sources on how to beat buy and hold." (p. 351)

Similarly, Fama and Blume (1966), who compared the profitability of various technical trading rules to a buy and hold strategy based on daily data on the individual stocks of the Dow-Jones Industrial Average, rejected the hypothesis that there was any important information in past prices that the market neglects in setting current prices. Reviewing both the Alexander and Fama–Blume tests, Fama (1976) subsequently observed that:

"Strictly speaking, then, the filters uncover evidence of market inefficiency, but the departures from efficiency do not seem sufficient for any trader to reject the hypothesis that the market is efficient so far as his own activities are concerned." (p. 142)

[1] The authors would like to thank the stockbroking divisions of Lloyds and Midland Banks, and the stockbroking firms of Henry Cooke Lumsden and BWD Rensburg for their valuable information regarding the trading costs faced by larger institutions.

Therefore, the present results support the conclusions of the early analyses of technical trading rules; namely, although the rules have predictive content, it is not sufficient to enable excess returns to be made in a costly trading environment.

5. Conclusions

This paper has sought to establish whether Brock et al.'s finding of technical trading rules having predictive ability is replicable on UK data. In general, the results presented here are remarkably similar to those offered by Brock et al. One conclusion to be drawn from both studies is that the technical trading rules have predictive ability if sufficiently long series of the stock indices are considered. However, the length of time needed to make returns may question the sustainability of the trading rules as practical investment tools. This caveat is added to when costly trading is brought into consideration. In the presence of actual trading costs, the rules are unlikely to make returns over and above a buy and hold strategy. As for trading on other noted anomalies (for example, weekend and seasonal effects), it is not possible to make excess returns from the examined technical trading rules in the face of costly trading. Hence, in contrast to the emphasis of Brock et al. "our results provide strong support for the technical trading strategies" (p. 1731), the present results are seen as supporting the weak form efficiency of financial markets.

Appendix A

Allied Lyons	British Telecom	ICI
ASDA	Cadbury Schweppes	Lucas Industries
BICC	Courtaulds	Marks and Spencer
BOC	Forte	National Westminster Bank
BTR	General Electric	P and O
Blue Circle Industries	Glaxo	Reuters
Boots	Grand Metropolitan	Royal Insurance Holdings
British Airways	GKN	Smithkline Beecham A
British Gas	Guinness	Tate and Lyle
British Petroleum	Hanson	Thorn EMI

References

Alexander, S.S., 1961, Price movements in speculative markets: Trends or random walks, Industrial Management Review 2 (May), 7–26; reprinted in: P. Cootner, ed., The random character of stock market prices (MIT, Cambridge) 199–218.

Alexander, S.S., 1964, Price movements in speculative markets: Trends or random walks, No. 2, in: P. Cootner, ed., The random character of stock market prices (MIT, Cambridge) 338–372.

Brock, W., J. Lakonishok and B. LeBaron, 1992, Simple technical trading rules and the stochastic properties of stock returns, Journal of Finance XLVII (5), 1731–1764.

BWD Rensburg, 1995, Premier Portfolio Service, Manchester, England.

Fama, E.F., 1976, Foundations of finance (Basil Blackwell, Oxford; Basic Books, New York).

Fama, E.F. and M. Blume, 1966, Filter rules and stock market trading profits, Journal of Business 39 (special suppl., January), 226–241.