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Abstract: We examine the performance of various types of technical trading rules in the Athens Stock Exchange (ASE). In particular, this study examines the predictability of daily returns for the ASE by using the various moving averages rules. Due to the problem of non-normality on distribution of the abnormal returns identified, the bootstrap methodology under the null models of AR(1) and GARCH(1,1) is proposed. Overall, our results provide strong support for the examined technical strategies.

JEL classification number: G12,G14

Key words: GARCH(1,1), AR(1), moving averages, bootstrap.

1. Introduction

Numerous empirical studies have tested the profitability of various technical trading systems. In the present paper we conducted an analysis of the stock market of Greece. So, the basic intention of the present study is to investigate the performance of various technical trading rules in the Athens Stock Exchange (ASE). The examined period 1995-2005 is a very important investigation period for the ASE as there are no studies for that period, the stock market has become a developed market (2001), Greece has adopted the euro currency, a successful derivatives market in introduced. Besides, Greece has entry to the European Exchange Rates Mechanism II (1998).

In most early studies, technical trading rules are applied to examine price behaviour in various speculative markets. Overall, early studies of stock markets found very limited evidence of the profitability of technical trading strategies (Fama and Blume 1966, Jensen and Bennington 1970). Modern studies greatly improved analytic techniques relative to those of early studies, with more advanced theories and statistical methods spurred on by rapid growth of computing power. About the results of modern studies the number of

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studies that identified profitable technical trading strategies is far greater than the number of studies that found negative results (Brock et al. 1992, Summers, Griffiths, Hudson 2004, Sullivan, Timmermann, White 2003, Rodriguez et al. 2003, Wong et al. 2003).

This paper considers the changes in the returns to the Brock et al. (1992) technical trading rules methodology on the ASE over the 1995–2005 period. Furthermore, we explore various types of moving averages. The methodology that is going to be used for the analysis of the data is standard tests. In addition, standard tests will be compared with the bootstrap methodology inspired by Efron (1979).

This paper contributes to the existing literature by:investigating the usefulness of Technical Analysis in Athens Stock Exchange and the performance of various technical trading in the large capitalization firms of the Athens Stock Exchange. Further, it investigating the performance of various technical trading rules in 60 stocks of the Athens Exchange (General Index) with the largest capitalization.

Section 2 describes the data and methodology used. Section 3 reports the findings of the research. Finally, in section 4 the concluding remarks of the research are summarized.

2. Data and Methodology

The database used is composed of 2,746 observations covering the period from 01/01/1995 to 12/31/2005 for the General Index. This index constituted from the 60 stocks of the ASE with the largest capitalization. The index reflects, 81% of the overall capitalization.

A moving average is an indicator that shows the average value of a security's price over a period of time. According to the moving average rule, buy and sell signals are generated by two moving averages of the level of the index: a long-period average and a short-period average. A typical moving average trading rule prescribes a buy (sell) when the short-period moving average crosses the long-period moving average from below (above). This moving average has an excellent track record in timing the major market cycles. These moving averages are used in this paper, as they are the most common in used by the chartists-technical analysts. We evaluate the following popular moving average rules: 1-9,1-15,1-30,1-60,1-90 and 1-120 where the first number in each pair indicates the days in the short period and the second number shows the days in the long period.

We will follow similar methodology with Brock et al. (1992) adding transaction costs. The investigation of these technical strategies will be achieved by comparing the returns given by the buy signals of the moving averages with the returns of the buy-and-hold-method. Furthermore, the returns given by the buy signals of the moving averages minus the returns of the sell signals of the moving average with the returns of the buy-and-hold-method will be compared. The hypothesis that the returns of the buy-and-hold-method with the returns

of the moving average will be examined using the t-test methodology which was used in the past in numerous studies for the investigation of technical rules (Levich, Thomas 1993, Gençay R. 1998, Balsara,Carlson,Rao, 1996). The t-test is used in order to assess if the means of two data groups are statistically different from each other in order to compare these means. The t-statistic is calculated by the formulas:

$$\frac{\mu_{buys(sells)} - \mu_{buy\&hold}}{\sqrt{(\frac{\sigma^2}{N_{obser}} + \frac{\sigma^2}{N_{buys(sells)}})}} \qquad \frac{\mu_{buys} - \mu_{sells}}{\sqrt{(\frac{\sigma^2}{N_{buys}} + \frac{\sigma^2}{N_{sells}})}} \qquad (1)$$

where σ^2 is the square root of the variance of the returns, μ is the mean return for the buys, sells, buy-and-hold-method, N is the number of signals for the buys, sells, observations.

The results of the t-test will help to either accept the null hypothesis (there is no actual difference between mean returns) or reject our null hypothesis (there is an actual difference the mean returns).

All transactions assume 0.08% (of the investing capital) commission as entry fees and 0.08% as exit fee.

The results presented in t-test assume independent, stationary and asymptotically normal distributions. Many times these assumptions certainly do not characterize the returns from the ASE series. Following Brock (1992), this problem can be solved using bootstrap methods (Efron and Tibshiarani, 1993). The general idea behind the bootstrap is to use resampling to estimate an empirical distribution for the statistic. In the bootstrap procedure our model is to fit the original series to obtain estimated parameters and residuals. We standardize the residuals using parameters standard deviations for the error process. The estimated residuals are then redrawn with replacement to form a scrambled residuals series, which is then used with the estimated parameters to form a new representative series for the given null model. Each of the simulation is based on 500 replications of the null model.

The first model we fit is a AR(1) process:

$$r_t = b + \rho_1 r_{t-1} + e_t \qquad (2)$$

where is r_t the t^{th} day return and e_t is independent and identically distributed.

The second model we fit is a GARCH(1,1) process:

$$r_t = \delta + \rho r_{t-1} + e_t;\ h_t = w + a e^2_{t-1} + b h_{t-1};\ \text{and } e_t = h^{1/2}_t z_t,\ z_t \sim N(0, 1) \qquad (3)$$

where e_t is an independent, identically distributed normal random variable, r_t is the conditional variance.

To test the significance of the trading rule excess returns the following hypothesis can be stated:

$$H_0: XR \leq \overline{XR}^* \qquad (4)$$
$$H_1: XR > \overline{XR}^*$$

Under the null hypothesis, the trading rule excess return calculated from the original series is less than or equal to the average trading rule return for the pseudo data samples. In order to test our hypothesis we will use the econometric program Matlab 7.0. The bootstrap methodology requires high computer power and computer programming.

3. Findings

3.1. Statistical results

Table 1 reports some summary statistics for daily returns. Returns are calculated as log differences of the ASE level. As can be seen, these returns exhibit excessive kurtosis and non-normality in returns.

Table 1: Descriptive Statistics

Max:	0.076606471	Kurtosis:	7.0575759807
Min:	-0.096151856	Jarquebera:	3.2656352
Std:	0.016163455	Jbpval:	0
Skewness:	-0.065285605	Buy-Hold Mean Return	0.000521307

Table 2: Standard Results for Moving Averages

Period	Test	N(buy)	N(sell)	Sum	Buy	Sell	Buy-Sell
01/01/1995	(1,9)	207	207	414	0.00107	-0.00054	0.00160
-					(3.908)	(-2.925)	(4.378)
12/31/2005	(1,15)	154	154	308	0.00095	-0.00041	0.00135
					(3.3442)	(-2.33368)	(3.5482)
	(1,30)	96	95	191	0.00082	-0.00028	0.00110
					(2.627)	(-1.859)	(2.737)
	(1,60)	63	63	126	0.00076	-0.00020	0.00096
					(2.268)	(-1.546)	(2.276)
	(1,90)	39	38	77	0.00073	-0.00022	0.00095
					(2.146)	(-1.658)	(2.268)
	(1,120)	29	28	57	0.00078	-0.00028	0.00106
					(2.325)	(-1.966)	(2.615)
	Average				**0.000850**	**-0.000320**	**0.001170**

If technical analysis does not have any power to forecast price movements, then we should observe that returns on days when the rules emit by signals do not differ appreciably from returns on days when the rules emit sell signals.

In Table 2 we present the results from moving average trading strategies. The rules differ by the length of the short and long period. In 3 and 4 columns we report the number of buy "N(Buy)" and sell "N(Sell)" signals generated during the period. The (daily) mean buy and sell returns are reported separately in columns 6 and 7. The last column "Buy-Sell" lists the differences between the mean daily buy and sell returns.

As we can see in Table 2, the buy-sell differences are significantly positive for all rules and the t-tests for these differences are highly significant rejecting the null hypothesis of equality with zero. [For 0.05 probability the upper critical values of the t-test values are +(-)1.960]. The mean buy-sell returns are all positive with an average daily return of 0.117% which is 29.25% at an annual rate (250 trading days x 0.117%). Besides, the mean buy returns are all positive with an average daily return of 0.085% which is 21.25% yearly. The t-statistics reject the null hypothesis that the returns equal the unconditional returns (0.0521% from Table I). All the tests reject the null hypothesis that the returns equal the unconditional returns at the 5 percent significance level.

3.2. Bootstrap Results

Table 3 contains estimation results for the AR(1) and GARCH(1,1) models which will be used for comparison with the actual ASE series.

Table 3: Parameter estimates for model

a)AR(1)

a	**b**
0,000429	0,169607
(1.398277)	(5.645678)

b)GARCH(1,1)

δ	**ρ**	**ω**	**a**	**b**
0,000413	0,17203	3,75e-006	0,1333	0,8593
(1.8309)	(8.808)	(5.9975)	(14.62)	(106.16)

Note: The AR(1) and GARCH(1,1) is estimated using maximum likelihood method. The numbers in parenthesis are t-ratios.

In Table 4 we present the results of AR(1) and GARCH(1,1) simulations using simple moving average trading strategies via bootstrapping. All the numbers presented in 4,5,6 columns are the fractions of the simulated result which are larger than the results for the original General Index of ASE which are p-values. The p-values

from the bootstrap procedure are then used to determine whether the trading rule excess returns significantly greater than the average trading rule return given from original series. The numbers in parenthesis in 4,5,6 columns show how many series from 500 replications are greater than from original returns. As we see from reported numbers in 4,5,6 columns most of the simulated AR(1) and GARCH(1,1) were greater than those from the General index of ASE series. All the buy, sell and buy-sell are highly significant accepting the null hypothesis. For 0.05 probability the p-value must be greater than 0.05. The results for the returns are consistent with the traditional tests presented earlier.

Table 4: Simulations Test for AR(1) and GARCH(1,1) Tests for 500 Replications

			AR(1)			GARCH(1,1)		
Period	Test	Results	Buy	Sell	Buy-Sell	Buy	Sell	Buy-Sell
01/01/1995	(1,9)	Fraction>General Index	1	0.908	0.998	0.812	0.812	0.812
-			(500)	(454)	(499)	(406)	(406)	(406)
12/31/2005	(1,15)	Fraction>General Index	0.998	0.844	1	0.822	0.822	0.822
			(499)	(422)	(500)	(411)	(411)	(411)
	(1,30)	Fraction>General Index	0.988	0.67	0.994	0.824	0.824	0.824
			(494)	(335)	(497)	(412)	(412)	(412)
	(1,60)	Fraction>General Index	0.982	0.5	0.958	0.828	0.828	0.828
			(491)	(250)	(479)	(414)	(414)	(414)
	(1,90)	Fraction>General Index	0.964	0.428	0.934	0.834	0.834	0.834
			(482)	(214)	(467)	(417)	(417)	(417)
	(1,120)	Fraction>General Index	0.972	0.342	0.928	0.86	0.86	0.86
			(486)	(171)	(464)	(430)	(430)	(430)
	Average		**0.980**	**0.573**	**0.958**	**0.833**	**0.163**	**0.599**

4. Conclusions

In this paper we have examined the performance of various types of technical trading rules in the Athens Stock Market. This study becomes necessary given that the examined period there are no studies for ASE performance, the stock market has become a developed market (2001), Greece has adopted the euro currency and a successful derivatives market in introduced.

This paper considers the changes in the returns to the Brock et al. (1992) technical trading rules methodology on the ASE over the 1995–2005 period. Furthermore we have investigated the performance of various moving averages rules for the General Index of ASE.

In our analysis we have used standards tests in combination with bootstrap methods. We have evaluated the following popular moving averages rules: 1-9,1-15, 1-30, 1-60, 1-90, and 1-120. These moving averages are used in this paper, as they are the most common used by the technical analysts.

All the buy-sell differences are positive and the t-tests for these differences are highly significant rejecting the null hypothesis of equality with zero. The mean buy-sell returns have an average daily return of 0.117% which is 29.25% at an annual rate. Besides, the mean buy returns have an average daily return of 0.085% which is 21.25% yearly. The t-statistics reject the null hypothesis that the returns equal the unconditional returns (0.0521%).

Overall our technical strategies win the market. In particular, buy-and-hold-strategy give us 13% per year profit and using moving averages strategy 29.25% for buy-sell method at an annual rate and using buys method 21.25% yearly. In addition, our results provide strong support for profitability for the examined technical trading rules.

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