PREDICTABILITY REVISITED: UK EQUITY RETURNS 1965–2007[1]

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ABSTRACT

This study tests a large sample of UK equity returns from 1965 to 2007 for predictability. Returns are tested using the Lo and MacKinlay (1988) variance ratio test and the Chow and Denning (1993) multiple variance ratio tests. Overall, the results show strong signs of predictability. There is a size effect, in which small equities appear more predictable in the first half of the sample (1965–1985), and mid- to large-size equities appear more predictable in the second half of the sample (1986–2007).

INTRODUCTION

Predictability-based trading strategies have become increasingly popular over the last decade. Equity market neutral, a strategy generally formulated from statistical analysis of past price movements (Patton, 2009), has assets under management globally increasing from $14 billion to $70 billion from 2001 to 2007.[2] However, the recent credit crisis has cast a shadow over these strategies with many funds delivering poor returns (Khandani and Lo, 2011), and it is now timely to question whether these strategies are based upon a false premise, i.e. are equity returns truly predictable? Our paper addresses this question by employing a range of tests for a large database of United Kingdom (UK) equities.

Our paper can also be considered a test of the Random Walk Theory (RWT) and also a limited test of the weak form of the Efficient Market Hypothesis (EMH). The RWT states that price changes must be unforecastable if they are properly anticipated (Samuelson, 1965), meaning returns are not predictable. Alternately, the weak form of the EMH states that abnormal profits (net of transaction costs) cannot be achieved based on analysis of past price movements. Comprehensive evidence of return predictability would naturally lead to a rejection of the RWT, whereas without a consideration of transaction costs we can draw fewer conclusions about EMH. On the other hand, evidence of no return predictability would provide evidence in support of both RWT and weak form EMH.

Researchers attempting to evaluate the predictability of equity returns are faced with several challenges. First, it is necessary to specify a long sample period in order to provide a robust test. Specifying a shorter time period means you are less likely to capture a wide range of market conditions. Second, it is necessary to specify a large sample of equities. It is likely that there is significant cross-sectional variation in return predictability and some evidence suggests that return predictability is a small stock phenomenon. Third, we need to allow for time variation in predictability. This is particularly relevant for trading strategies based upon predictability as profitability depends upon it being independent of time. Fourth, there are several implementation issues associated with statistical tests of predictability.

In this paper we address each of these difficulties. We specify a 42-year sample period of UK equities. Within the sample we specify over 6,700 UK equities. This is the largest and longest sample period that we are aware of in a study of this nature using UK data. To allow for time variation we repeat tests in several sub-sample periods. We further divide our sample into deciles based upon market capitalisation, controlling for cross-sectional variation in results (see below for more details?). The statistical tests we carry out are (1) simple Autocorrelation Functions (ACF) with Ljung-Box tests for serial correlation, (2) Lo and MacKinlay (1988) (hereafter LM) homoscedastic and heteroscedastic Variance Ratio tests and (3) Chow and Denning (1993) (hereafter CD) Multiple Variance Ratio Tests.

The LM variance ratio test is a simple specification model based on variance estimators that can be used to test whether a series follows a random walk. The variance ratio test exploits the fact that intervals of a random walk are linear. For example, a five-day period variance of a time series should be five times as large as a daily variance of the same time series. Chow and Denning (1993) make a modification to the standard variance ratio test to allow for the joint testing of multiple variance ratios. They argue that instead of examining several variance ratios at different aggregate intervals against the standard statistical critical value, it is appropriate to consider an overall critical value that takes into account the number of variance ratios being tested.

When we specify these different tests our empirical results generally find evidence of predictability. While we do provide evidence that stock price movement contains predictable components, there is considerable cross-sectional and time variation in our results. Consistent with prior research (see, for example, Lo and MacKinlay, 1988; Poterba and Summers, 1988; and Lovatt et al., 2007), we find strong signs of serial dependence throughout the sample. When measured by variance ratios, signs of predictability are also present across all time periods and throughout the full sample. The mid- to large-sized deciles of the full sample, notably the sixth to ninth deciles, report the highest number of significant variance ratios. The smaller deciles, second to fourth, have a number of insignificant variance ratios. When we specify the CD tests, joint variance test results suggest evidence of predictability in the mid- to large-sized deciles. However, in the smaller deciles, a number of variance ratios that would be reported as significant with a conventional LM variance ratio test are found to be insignificant. When the sample is divided into the four sub-samples, these incorrect LM significant variance ratios are only present in the third time period, 1986–1996.

Taken in aggregate, these results challenge the classical finance view that financial markets follow a random walk and suggest that there are opportunities to follow statistical arbitrage strategies, based on past price movements, in the UK equity market. In this paper we build on several related themes. There is a considerable body of research that focuses on the predictability of UK equity data with mixed findings. (See, for example, Malliaropulos, 1996; Belaire-Franch and Opong, 2005; Lovatt et al., 2007). These studies have generally focused on UK equity indices (Malliaropulos, 1996; Patro and Wu, 2004; Belaire-Franch and Opong, 2005) or relatively short sample periods (Lovatt et al., 2007). We build on each of these studies, providing more evidence on return predictability for a larger sample over a longer sample period, using a range of statistical tests.

A growing body of research is focused on the profitability of statistical trading strategies. Several authors, including Conrad and Kaul (1998) and Jegadeesh and Titman (1993, 1995, 2001), provide evidence from the United States (US) on momentum and contrarian investment strategy profitability. Likewise, in the UK, Antoniou et al. (2006) and Galariotis et al. (2007) report similar findings. With a very extensive test of predictability in UK equities, we present evidence supporting these studies, demonstrating that stock prices do not follow a random walk.

The rest of the paper is structured as follows. The next section describes the data, while the following section presents the predictability testing methodology. Then we report the empirical results, including variance ratio and multiple variance ratio predictability tests. The final section concludes.

DATA

We test for predictability in UK equities using a database of over 20 million daily equity returns over a sample period from 1965 to 2007, a time period that covers several market upturns and downturns, as well as relatively calm and volatile periods.[3] All data comes from We include failed firms in the dataset up to the date they are delisted from the London Stock Exchange, which helps to alleviate survival bias in the sample. Acquired firms' returns are included in the dataset up to the date they are delisted from the London Stock Exchange. We also omit all non-common equities from the sample. In addition, we manually scan the database for extremely high returns, which are then reversed in the following month as this indicates a data entry error. We remove these returns.[4,5]

In our final sample we have a total of 6,729 equity securities, ranging from large to small capitalisation stocks. On average, in any one year, there are 1,872 securities in the sample. The year with the smallest (largest) samples is 1965 (2007), with a total number of 786 (2,225) securities.

To ensure our results are independent of firm size, at the beginning of each year we sort stocks into portfolio deciles based upon end-of-prior-year market capitalisation. The first portfolio represents the smallest stocks by market capitalisation and the tenth the largest. Within each portfolio stocks are equally weighted.[6]

To investigate whether predictability is consistent across time periods we also divide our sample into four sub-samples: from 1 January 1965 to 31 December 1974; from 1 January 1975 to 31 December 1985; from 1 January 1986 to 31 December 1996; and from 1 January 1997 to 31 December 2007.

Table 1, Panel A displays the summary statistics for the equally weighted portfolios for the entire sample period. The mean returns for the sample are 6.30 per cent. As size increases across the deciles, the standard deviation levels correspondingly increase. As liquidity is directly related to firm size it is likely that the small stocks may trade less frequently than large stocks, with a consequent downward effect on standard deviation (Scholes and Williams, 1977). Each decile displays low levels of negative skewness; however, this is higher in the smaller deciles. The kurtosis levels also appear to be size dependent: as size increases across each decile, the kurtosis levels decrease. The minimum values (-12.24 per cent) for the full sample occurs on 20 October 1987. The maximum value of 6.57 per cent for the equally weighted portfolio occurs on 27 October 1975.

The summary statistics for the full sample over the four separate sample subperiods are reported in Table 1, Panel B. The period 1975–1985 has the highest mean returns, 21.71 per cent. The lowest returns occur in the fourth time period, 1997–2007, with annual mean returns of -6.06 per cent. Based on the summary statistics, it is evident that the returns vary quite considerably across the time periods investigated in this study.

Table 1: Summary Statistics

Panel A contains 10 equally weighted portfolios of daily returns for all equities listed in the UK from 31 December 1965 to 31 December 2007, decile 1 being the smallest and decile 10 being the largest. Panel B looks at all equities over four time periods: 1965–1974, 1975–1985, 1986–1997 and 1998–2007.

Panel A	**Annual Mean**	**Annual Median**	**Annual Standard Deviation**	**Skewness**	**Kurtosis**	**Minimum**	**Maximum**
Decile 1	10.32	6.19	8.27	-2.04	48.13	-10.47	5.18
Decile 2	4.97	5.63	8.65	-3.10	74.63	-11.82	6.64
Decile 3	3.42	5.69	8.96	-2.62	62.77	-12.80	7.54
Decile 4	4.14	6.20	9.26	-2.45	50.88	-11.88	6.68
Decile 5	3.42	6.01	9.46	-2.14	41.50	-10.95	7.26
Decile 6	4.90	6.15	9.74	-1.90	39.47	-11.12	8.64
Decile 7	5.81	6.63	10.48	-1.61	32.41	-10.61	8.22
Decile 8	6.20	5.99	11.40	-1.31	28.55	-11.19	7.89
Decile 9	8.69	5.37	13.38	-0.60	20.10	-13.27	8.62
Decile 10	7.95	5.10	14.46	-0.64	19.62	-15.14	8.94
Full Sample	*6.30*	*7.17*	*8.91*	*-2.46*	*52.26*	*-12.24*	*6.57*

(Continued)

Table 1: (Continued)

Panel B	Annual Mean	Annual Median	Annual Standard Deviation	Skewness	Kurtosis	Minimum	Maximum
1965–1974	3.73	5.45	9.06	-1.60	24.25	-6.95	3.77
1975–1985	21.71	24.07	8.82	0.83	22.38	-4.74	6.57
1986–1996	5.60	10.24	9.58	-6.01	110.95	-12.24	4.90
1997–2007	-6.06	10.41	8.03	-1.98	14.44	-4.65	2.40

METHODOLOGY

In this paper, to test for predictability we specify two variations of the variance ratio test, the standard LM variance ratio test and the CD multiple variance ratio test. Below we review the details of these tests.

The random walk theory in financial literature states that future stock returns cannot be predicted by previous stock prices. If equities follow RWT, the variance should be uncorrelated and should follow a linear pattern over time. Therefore, the variance ratio at time *k* should be *k* times the variance of its first difference. The LM variance ratio is defined as

$$m = q(nq - q + 1)(1 - \frac{q}{nq}) \tag{1}$$

where $\sigma_b^2(q)$ and $\sigma_a^2(q)$ are the maximum likelihood estimators of $1/q$ of the variance of the qth difference and the first difference of X_t, the return time series. Below, the formulas for $\sigma_b^2(q)$ and $\sigma_a^2(q)$ are defined in (2) and (4).

$$\sigma_a^2(q) = \frac{1}{nq-1}\sum_{t=1}^{nq}(X_t - X_{t-1} - \hat{\mu})^2 \tag{2}$$

where:

$$\hat{\mu} = \frac{1}{nq-1}(X_{nq} - X_0) \tag{3}$$

$$\phi(q) = \frac{2(2q-1)(q-1)}{3q(nq)} \tag{4}$$

where:

$$Z(q) = \frac{VR(q) - 1}{\left[\phi(q)\right]^{\frac{1}{2}}} \overset{a}{\sim} N(0,1) \tag{5}$$

The asymptotic variance of the variance-ratio under homoscedasticity is shown below in (6).

$$\phi^*(q) = \sum_{j=1}^{q-1} \left[\frac{2(q-j)}{q}\right]^2 \hat{\delta}(j) \tag{6}$$

$Z(q)$, the standard normal test statistic under homoscedasticity, is shown below.

$$\hat{\delta}(j) = \frac{\sum_{t=j+1}^{nq} (X_t - X_{t-1} - \hat{\mu})^2 (X_{t-j} - X_{t-j-1} - \hat{\mu})^2}{\left[\sum_{k=1}^{nq} (X_t - X_{t-1} - \hat{\mu})^2\right]^2} \tag{7}$$

$\varphi^*(q)$ represents the heteroscedasticity consistent asymptotic variance of the variance ratio and is defined as:

$$Z^*(q) = \frac{VR(q) - 1}{\left[\phi^*(q)\right]^{\frac{1}{2}}} \overset{a}{\sim} N(0,1) \tag{8}$$

where:

$$VR(q) = \frac{\sigma_b^2(q)}{\sigma_a^2(q)} \tag{9}$$

As stock returns are often non-normally distributed and heteroscedastic, Lo and MacKinlay (1988) define $Z^*(q)$ as:

$$\sigma_b^2(q) = \frac{1}{m} \sum_{t=q}^{nq} (X_t - X_{t-q} - q\hat{\mu})^2 \tag{10}$$

In this study we estimate variance ratios at two-, three-, four-, five-, ten- and twenty-day frequencies.

Chow and Denning (1993) argue that the RWT requires that all variance ratios across all aggregate observations should be equal to one. Therefore, they develop a joint variance ratio test of the null hypothesis of the RWT with multiple comparisons of all selected variance ratio estimates that are equal to one. The CD multiple variance ratio test is a modification of the standard variance ratio test designed by Lo and MacKinlay (1988). Chow and Denning (1993) demonstrate that it is only necessary to consider the largest absolute value of the test statistic. The maximum heteroscedasticity consistent test statistic is defined as:

$$Z_2^*(q) = \max_{1 \le i \le m} \left| Z^*(q_i) \right| \tag{11}$$

where the confidence interval of at least 100(1-α) per cent for the extreme statistic is:

$$Z_2^*(q) \pm SMM(\alpha; m; \infty) \tag{12}$$

$\mathrm{SMM}(\alpha; m; \infty)$ is the asymptotic critical value of the α-point of Studentized Maximum Modulus (SMM) distribution with m (number of variance ratios) and ∞ (sample size) degrees of freedom. The SMM can also be calculated from the conventional standard normal distribution as displayed in Equation 15. Chow and Denning (1993) also note that the SMM table can be found in Hahn and Hendrickson (1971) and Stolin and Ury (1979).

$$SMM(\alpha; m; \infty) = Z_{\alpha+/2} \tag{13}$$

where:

$$\alpha^{+} = 1 - (1 - \alpha)^{1/m} \tag{14}$$

The multiple variance ratio test statistic at the 5 per cent significance level for six variance ratio and ∞ degrees of freedom is calculated to ± 2.632.[7] Therefore, the CD maximum test statistic can be compared to results from the LM conventional variance ratio tests. If the value for $Z^*(q)$ is greater than the SMM critical value of 2.632, then the RWT is rejected.

RESULTS

As discussed in the previous section, in order to test for predictability we specify three separate tests: ACFs, the LM variance ratio test, and the CD multiple variance ratio test. In this section of the paper we report results for each of these tests for equal weighted size decile portfolios across four eleven-year time periods.

ACF Tests

Table 2 displays the ACFs as well as the corresponding Q statistics for the equally weighted deciles for the entire sample period. The autocorrelation coefficients and Q-statistics are reported at various lags ranging from one to twenty. Studies such as Lo and MacKinlay (1988), Poterba and Summers (1988) and Lovatt et al. (2007) have shown that equity data may display significant positive autocorrelation in the short term. The deciles show strong signs of autocorrelation, as evidenced by their Q-statistics, which are significant at the 1 per cent level across all deciles and over all lags. The fifth to eighth deciles report the highest autocorrelation coefficients and Q-statistics. For example, in the seventh equally weighted decile, 33.8 per cent of returns are explained by the previous day's returns. The highly significant Q-statistics support rejection of the null hypothesis that UK stocks follow a random walk over the sample period.

Table 2: Autocorrelations of Continuously Compounded Daily Returns from 1 January 1965 to 31 December 2007 (Q Statistics)

Panel A	**Autocorrelations of Continuously Compounded Equally Weighted Daily Returns**						
Lags	**1**	**2**	**3**	**4**	**5**	**10**	**20**
Decile 1	0.212	0.145	0.133	0.151	0.126	0.144	0.100
	(503.5)***	(738.4)***	(937.7)***	(1192)***	(1369.4)***	(2155)***	(2910.8)***
Decile 2	0.249	0.196	0.150	0.168	0.145	0.158	0.117
	(694.9)***	(1126.1)***	(1377.9)***	(1694.4)***	(1929.9)***	(2866.1)***	(3816.3)***
Decile 3	0.258	0.180	0.137	0.154	0.132	0.137	0.102
	(748.2)***	(1112.3)***	(1323.4)***	(1587.8)***	(1782.2)***	(2509.5)***	(3288.8)***
Decile 4	0.294	0.190	0.143	0.151	0.132	0.134	0.096
	(968.5)***	(1372.6)***	(1601.3)***	(1856.1)***	(2051)***	(2813.7)***	(3461.1)***
Decile 5	0.331	0.202	0.160	0.155	0.141	0.124	0.075
	(1227.6)***	(1685.2)***	(1973.9)***	(2244.2)***	(2466.6)***	(3193.5)***	(3814.5)***
Decile 6	0.332	0.203	0.157	0.149	0.139	0.133	0.064
	(1234.7)***	(1697.7)***	(1975.2)***	(2224.2)***	(2439.9)***	(3119.6)***	(3629)***
Decile 7	0.338	0.191	0.143	0.132	0.122	0.122	0.064
	(1281.5)***	(1692.4)***	(1922.1)***	(2119.1)***	(2285.6)***	(2832.9)***	(3243.7)***
Decile 8	0.320	0.164	0.139	0.126	0.112	0.114	0.050
	(1146.7)***	(1448.2)***	(1664)***	(1842.2)***	(1982.2)***	(2384.1)***	(2660)***
Decile 9	0.242	0.091	0.079	0.081	0.063	0.085	0.045
	(659.3)***	(753.2)***	(822.9)***	(897.1)***	(942.1)***	(1115.1)***	(1226.6)***
Decile 10	0.085	0.018	0.023	0.039	0.002	0.047	0.049
	(80.3)***	(84)***	(89.8)***	(107)***	(107)***	(148.3)***	(204.1)***
Full Sample	*0.321*	*0.178*	*0.145*	*0.153*	*0.126*	*0.138*	*0.079*
	*(1154.8)****	*(1512.3)****	*(1749.3)****	*(2011.6)****	*(2189.8)****	*(2870.6)****	*(3414.7)****

Note: *** indicates significance at the 1% level

Separating the sample into four sub-samples helps to determine if autocorrelation coefficients are consistent across all time periods. The equal weighted decile ACF and Q-statistics for the period 1965–1974 are reported in Table 3, Panel A. Panel B contains the 1975–1985 period results, while Panels C and D display the results for 1986–1996 and 1997–2007 respectively.

In Table 3, Panel A, all Q-statistics reported across all deciles and lags are significant at the 1 per cent level. The deciles that report the highest Q-statistics for the first four lags are the fifth to eighth deciles. This suggests that mid- to large-sized equities have the highest level of autocorrelation. Comparing deciles, the sixth decile reports the highest level of autocorrelation at 34.1 per cent. However, examining the tenth and twentieth lags, it appears that smaller securities have higher autocorrelations and Q-statistics. For the second time period, 1975–1985, the autocorrelation coefficients are all shown to be positive and significant. The fourth decile reports the highest first order autocorrelation coefficient of 44.8 per cent. Compared to Panel A in the second period, it appears that the autocorrelation coefficients are higher in the lower lags. In Panel C, the tenth decile has negative autocorrelations of -3.6 per cent and -2.1 per cent in the first two lags. These are both significant at the 10 per cent level. For the fourth and final time period, 1997–2007, the equally weighted portfolio's autocorrelations are positive and significant at the 1 per cent level across all lags and all deciles, with the exception of the tenth decile. The tenth decile reports insignificant autocorrelations in the first two lags and significant negative autocorrelation coefficients for lags 3 and 5, 10 and 20.

The results in Table 3 provide evidence that a considerable proportion of the variation of current day returns is predictable from past returns, supporting findings in the literature (see Lovatt et al., 2007). For example, for the full sample portfolios between 25 per cent (1986–1996) and 42 per cent (1975–1996) of the variation of current day returns is predictable from prior day returns. At longer lags, between 4 per cent (1997–2007) and 11 per cent (1965–1974) of the variation in current day returns is predictable from the returns from twenty days previously. These results provide early evidence that UK equity returns do not appear to follow a random walk.

Variance Ratio Tests

The homoscedasticity and heteroscedasticity consistent variance ratios for the equally weighted portfolios within the entire sample period are reported in Panels A and B of Table 4 respectively. Examining the homoscedastic consistent variance ratios, the results suggest that predictability is evident across all deciles at every number of q base observations. The deciles with the highest homoscedasticity-consistent test statistics are generally the sixth to the eight deciles. The tenth decile reports significant variance ratios; however, unlike the rest of the deciles the variance ratios are negative, indicating mean reversion. The highly significant $Z(q)$ values for all deciles and for the full sample supports a rejection of the null hypothesis that UK equity returns follow a random walk.

Table 3: Autocorrelations of Continuously Compounded Daily Returns for Sub-Sample Periods (Q-statistics)

	Panel A							Panel B						
	Autocorrelations of Equally Weighted Continuously Compounded Daily Returns 1965–1974							Autocorrelations of Equally Weighted Continuously Compounded Daily Returns 1975–1985						
Lags	*1*	*2*	*3*	*4*	*5*	*10*	*20*	*1*	*2*	*3*	*4*	*5*	*10*	*20*
Decile 1	0.167	0.118	0.103	0.089	0.205	0.246	0.179	0.331	0.234	0.184	0.127	0.123	0.098	0.085
	(72.9)***	(109.2)***	(137.1)***	(157.8)***	(267.4)***	(510.2)***	(763.5)***	(314)***	(471)***	(568.9)***	(615.2)***	(658.7)***	(753.1)***	(843.6)***
Decile 2	0.238	0.168	0.132	0.121	0.261	0.212	0.231	0.376	0.241	0.163	0.074	0.089	0.132	0.089
	(147.4)***	(221.3)***	(266.8)***	(305)***	(482.9)***	(701.9)***	(1005.6)***	(406.7)***	(573.1)***	(649.7)***	(665.3)***	(687.9)***	(788.3)***	(905.4)***
Decile 3	0.272	0.179	0.140	0.118	0.245	0.240	0.179	0.429	0.254	0.180	0.098	0.079	0.104	0.086
	(193.1)***	(276.6)***	(327.9)***	(364.3)***	(521.4)***	(766.8)***	(1105.2)***	(528.3)***	(714.4)***	(807.9)***	(835.3)***	(853.5)***	(905.9)***	(991.9)***
Decile 4	0.303	0.188	0.123	0.130	0.242	0.198	0.140	0.448	0.228	0.165	0.086	0.060	0.099	0.071
	(240.3)***	(332.4)***	(371.7)***	(415.6)***	(568.7)***	(791.5)***	(1025.8)***	(577.7)***	(727.7)***	(806.2)***	(827.4)***	(837.8)***	(887)***	(940.6)***
Decile 5	0.328	0.185	0.120	0.102	0.230	0.168	0.089	0.433	0.233	0.184	0.091	0.067	0.075	0.063
	(281.5)***	(371.1)***	(408.6)***	(436)***	(574)***	(740.2)***	(913.4)***	(537.4)***	(693.6)***	(791)***	(814.6)***	(827.5)***	(868.7)***	(924.2)***
Decile 6	0.341	0.192	0.106	0.098	0.218	0.165	0.075	0.401	0.203	0.184	0.084	0.070	0.097	0.053
	(303)***	(399.6)***	(428.7)***	(453.8)***	(577.7)***	(730.7)***	(909.7)***	(463)***	(581.2)***	(678.4)***	(698.6)***	(712.8)***	(752)***	(799.9)***
Decile 7	0.339	0.176	0.094	0.093	0.180	0.156	0.080	0.389	0.157	0.141	0.055	0.058	0.103	0.083
	(300.7)***	(381.2)***	(404.5)***	(426.9)***	(511.8)***	(637.7)***	(791.2)***	(434.7)***	(505.5)***	(562.5)***	(571.3)***	(580.9)***	(627.5)***	(680)***
Decile 8	0.318	0.152	0.095	0.087	0.172	0.127	0.048	0.352	0.121	0.134	0.073	0.044	0.117	0.074
	(264.3)***	(324.8)***	(348.3)***	(367.9)***	(445.7)***	(544)***	(664.5)***	(355.5)***	(397.9)***	(449.4)***	(464.5)***	(470.1)***	(520.5)***	(574.3)***
Decile 9	0.277	0.115	0.068	0.056	0.141	0.104	0.051	0.289	0.061	0.097	0.052	0.030	0.115	0.081
	(200.9)***	(235.7)***	(247.9)***	(255.9)***	(307.7)***	(366.2)***	(429.1)***	(240.5)***	(251.3)***	(278.3)***	(286)***	(288.7)***	(338.2)***	(389.6)***
Decile 10	0.200	0.055	0.006	0.029	0.045	0.075	0.054	0.189	0.034	0.078	0.038	0.000	0.094	0.050
	(104.9)***	(112.8)***	(112.9)***	(115.1)***	(120.3)***	(146.4)***	(182.5)***	(102.4)***	(105.8)***	(123.1)***	(127.3)***	(127.3)***	(162.9)***	(182.2)***
Full Sample	*0.313*	*0.169*	*0.107*	*0.106*	*0.226*	*0.195*	*0.110*	*0.419*	*0.185*	*0.173*	*0.091*	*0.059*	*0.122*	*0.082*
	*(255)****	*(329.9)****	*(359.6)****	*(388.7)****	*(522.3)****	*(701.4)****	*(908.6)****	*(503.5)****	*(602.2)****	*(688.3)****	*(712.2)****	*(722.2)****	*(789.9)****	*(862.3)****

(Continued)

Table 3: (Continued)

	Panel C							Panel D						
	Autocorrelations of Equally Weighted Continuously Compounded Daily Returns 1986–1996							Autocorrelations of Equally Weighted Continuously Compounded Daily Returns 1997–2007						
Lags	*1*	*2*	*3*	*4*	*5*	*10*	*20*	*1*	*2*	*3*	*4*	*5*	*10*	*20*
Decile 1	0.201	0.126	0.121	0.185	0.079	0.133	0.084	0.164	0.111	0.112	0.122	0.120	0.099	0.058
	(115.6)***	(161.3)***	(203.3)***	(301.9)***	(319.8)***	(565.4)***	(804)***	(77.5)***	(112.7)***	(148.8)***	(191.7)***	(233.3)***	(361)***	(468.2)***
Decile 2	0.171	0.161	0.109	0.200	0.078	0.142	0.080	0.271	0.212	0.186	0.179	0.163	0.123	0.071
	(83.7)***	(158.3)***	(192.3)***	(307.3)***	(324.7)***	(593)***	(840.7)***	(210.3)***	(339.4)***	(438.4)***	(530.5)***	(606.9)***	(836.8)***	(1057.4)***
Decile 3	0.167	0.136	0.090	0.199	0.061	0.102	0.066	0.216	0.157	0.136	0.133	0.141	0.091	0.063
	(80.1)***	(133)***	(156.5)***	(270.3)***	(281)***	(536.8)***	(745.5)***	(134)***	(204.5)***	(258)***	(308.5)***	(366)***	(508.1)***	(653.9)***
Decile 4	0.209	0.163	0.109	0.205	0.080	0.133	0.082	0.239	0.171	0.163	0.132	0.135	0.082	0.069
	(125.1)***	(201.9)***	(236.1)***	(357.5)***	(376)***	(677.4)***	(882.8)***	(164.6)***	(248.6)***	(325)***	(375.2)***	(427.9)***	(609.1)***	(756)***
Decile 5	0.245	0.187	0.146	0.217	0.107	0.126	0.063	0.310	0.185	0.175	0.186	0.149	0.108	0.063
	(172)***	(272.4)***	(333.9)***	(469.3)***	(502.4)***	(825.6)***	(1058)***	(276.7)***	(375.3)***	(463)***	(562)***	(625.6)***	(864.4)***	(1052.1)***
Decile 6	0.250	0.209	0.158	0.229	0.107	0.147	0.062	0.315	0.194	0.165	0.173	0.156	0.105	0.052
	(179.5)***	(305.1)***	(377.2)***	(528.6)***	(561.5)***	(905.7)***	(1130.4)***	(285.6)***	(393.8)***	(472.4)***	(558)***	(628)***	(879.4)***	(1013.9)***
Decile 7	0.275	0.227	0.163	0.232	0.122	0.134	0.045	0.320	0.210	0.171	0.169	0.127	0.083	0.012
	(217.3)***	(365.2)***	(441.4)***	(596.4)***	(639)***	(956.3)***	(1158.1)***	(293.4)***	(420.1)***	(504.4)***	(586.3)***	(632.7)***	(821.1)***	(914.6)***
Decile 8	0.299	0.192	0.154	0.217	0.110	0.125	0.030	0.283	0.201	0.172	0.152	0.124	0.066	0.011
	(256.5)***	(362.6)***	(430.8)***	(566.5)***	(601.4)***	(810.3)***	(925)***	(230)***	(346)***	(430.8)***	(497.4)***	(541.9)***	(670.7)***	(722.6)***
Decile 9	0.217	0.098	0.084	0.138	0.063	0.088	0.013	0.165	0.096	0.055	0.087	0.028	0.022	0.009
	(134.9)***	(162.6)***	(182.7)***	(237.1)***	(248.5)***	(316.7)***	(354.2)***	(78.3)***	(104.8)***	(113.5)***	(135.1)***	(137.4)***	(172)***	(194)***
Decile 10	-0.036	-0.021	0.053	0.055	0.002	0.043	0.086	0.020	0.010	-0.047	0.029	-0.037	-0.019	-0.004
	(3.7)*	(5)*	(13)***	(21.6)***	(21.6)***	(31.9)***	(81.2)***	(1.1)	(1.4)	(7.7)*	(10.2)**	(14.1)**	(23.4)***	(42.7)***
Full Sample	*0.242*	*0.152*	*0.124*	*0.210*	*0.084*	*0.126*	*0.057*	*0.309*	*0.200*	*0.168*	*0.181*	*0.130*	*0.089*	*0.044*
	*(167.9)****	*(234)****	*(277.8)****	*(404.2)****	*(424.4)****	*(675.7)****	*(855.2)****	*(273.9)****	*(388.3)****	*(469.3)****	*(563.2)****	*(611.7)****	*(835.1)****	*(975.7)****

Note: ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively

Table 4: Variance Ratios for Continuously Compounded Daily Returns for UK Equities Returns at Various Aggregations, 1 January 1965 to 31 December 2007 for 10 Equally Weighed Portfolios

Panel A	**Variance Ratio Test Under Homoscedastic Conditions Time Series Equally Weighted**					
	Number (q) of base observations aggregated to form variance ratio					
	2	**3**	**4**	**5**	**10**	**20**
Decile 1	1.18	1.32	1.44	1.59	2.14	3.14
	(19.03)***	(22.54)***	(25.16)***	(28.56)***	(35.83)***	(45.57)***
Decile 2	1.15	1.29	1.40	1.55	2.05	2.99
	(16.00)***	(20.92)***	(22.77)***	(26.4)***	(33.03)***	(42.47)***
Decile 3	1.14	1.26	1.36	1.50	1.99	2.84
	(15.01)***	(18.75)***	(20.4)***	(24.00)***	(30.98)***	(39.28)***
Decile 4	1.19	1.35	1.47	1.62	2.18	3.11
	(20.32)***	(24.55)***	(26.49)***	(29.74)***	(36.94)***	(44.95)***
Decile 5	1.23	1.42	1.57	1.74	2.41	3.42
	(24.69)***	(29.73)***	(32.24)***	(35.96)***	(44.22)***	(51.60)***
Decile 6	1.24	1.44	1.61	1.79	2.50	3.55
	(25.58)***	(31.37)***	(34.51)***	(38.29)***	(47.08)***	(54.25)***
Decile 7	1.28	1.51	1.71	1.90	2.63	3.67
	(29.66)***	(36.48)***	(39.95)***	(43.49)***	(51.26)***	(56.98)***
Decile 8	1.28	1.50	1.69	1.87	2.54	3.39
	(29.90)***	(35.56)***	(38.90)***	(41.98)***	(48.32)***	(51.01)***
Decile 9	1.14	1.24	1.31	1.38	1.62	1.93
	(14.58)***	(16.77)***	(17.47)***	(18.4)***	(19.30)***	(19.80)***
Decile 10	0.95	0.93	0.91	0.90	0.87	0.90
	(-5.27)***	(-5.29)***	(-5.29)***	(-4.62)***	(-3.98)***	(-2.14)**
Full Sample	*1.25*	*1.44*	*1.59*	*1.76*	*2.40*	*3.38*
	*(26.67)****	*(31.01)****	*(33.44)****	*(36.75)****	*(43.97)****	*(50.68)****

(Continued)

Table 4, Panel B reports the results using the heteroscedasticity-consistent test statistics for the equally weighted portfolios. The results are weaker than the results from Panel A but still support a rejection of the RWT. Deciles 1 and 4–9 and the full sample are statistically significant across all aggregate observations. Deciles 6–9 report the highest associated test statistic across all aggregate observations. The variance ratio of Decile 10 is negative and statistically insignificant for all values of q, suggesting that the largest of the UK equities do not show signs of predictability over the sample period. Lo and MacKinlay (1988) report similar results for large capitalisation stocks in the US. Deciles 2–4 do not show signs of significance until the lagged observations are at least four days.

Table 4: (Continued)

Panel B	Variance Ratio Test Under Heteroscedastic Conditions Time Series Equally Weighted					
Decile 1	1.18	1.32	1.44	1.59	2.14	3.14
	(2.38)**	(3.03)***	(3.60)***	(4.23)***	(5.86)***	(8.51)***
Decile 2	1.15	1.29	1.40	1.55	2.05	2.99
	(1.06)	(1.49)	(1.72)*	(2.06)**	(2.82)***	(4.21)***
Decile 3	1.14	1.26	1.36	1.50	1.99	2.84
	(0.97)	(1.30)	(1.50)	(1.84)*	(2.7)***	(4.01)***
Decile 4	1.19	1.35	1.47	1.62	2.18	3.11
	(1.73)*	(2.24)**	(2.56)**	(2.96)***	(4.01)***	(5.65)***
Decile 5	1.23	1.42	1.57	1.74	2.41	3.42
	(2.23)**	(2.87)***	(3.30)***	(3.78)***	(5.00)***	(6.63)***
Decile 6	1.24	1.44	1.61	1.79	2.50	3.55
	(3.12)***	(4.04)***	(4.69)***	(5.31)***	(6.9)***	(9.06)***
Decile 7	1.28	1.51	1.71	1.90	2.63	3.67
	(4.57)***	(5.85)***	(6.67)***	(7.41)***	(9.27)***	(11.69)***
Decile 8	1.28	1.50	1.69	1.87	2.54	3.39
	(5.75)***	(7.27)***	(8.43)***	(9.36)***	(11.48)***	(13.68)***
Decile 9	1.14	1.24	1.31	1.38	1.62	1.93
	(4.77)***	(5.66)***	(6.06)***	(6.5)***	(7.18)***	(7.87)***
Decile 10	0.95	0.93	0.91	0.90	0.87	0.90
	(-1.37)	(-1.48)	(-1.57)	(-1.44)	(-1.44)	(-0.86)
Full Sample	*1.25*	*1.44*	*1.59*	*1.76*	*2.40*	*3.38*
	*(2.73)****	*(3.42)****	*(3.95)****	*(4.51)****	*(5.98)****	*(8.03)****

Note: ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively

Multiple Variance Ratio Test

In this section, we provide results from the CD multiple variance ratio test, which is a sterner test of predictability. Below we also outline instances where, according to the CD test, the results for the LM variance ratio test would be due to inference errors.

Results under heteroscedastic conditions are reported in Table 5. It appears that only the mid- to large-sized equities have signs of predictability in their returns. The sixth to ninth deciles and the full sample are significant across all aggregated observations. The smaller portfolios, first to fifth deciles, all report insignificant variance ratios, as well as variance ratios that are incorrectly reported as significant under the LM variance ratio tests.

Table 5: Multiple Variance Ratios for Continuously Compounded Daily Returns for UK Equities Returns at Various Aggregations for 10 Equally Weighted Deciles from 1 January 1965 to 31 December 2007 under Heteroscedastic Conditions

Panel A	**Variance Ratio Test Equally Weighted Time Series**					
	Number (q) of base observations aggregated to form variance ratio					
	2	**3**	**4**	**5**	**10**	**20**
Decile 1	1.18	1.32	1.44	1.59	2.14	3.14
	(2.38)[b]	(3.03)[a]	(3.60)[a]	(4.23)[a]	(5.86)[a]	(8.51)[a]
Decile 2	1.15	1.29	1.40	1.55	2.05	2.99
	(1.06)	(1.49)	(1.72)	(2.06)[b]	(2.82)[a]	(4.21)[a]
Decile 3	1.14	1.26	1.36	1.50	1.99	2.84
	(0.97)	(1.30)	(1.50)	(1.84)	(2.7)[a]	(4.01)[a]
Decile 4	1.19	1.35	1.47	1.62	2.18	3.11
	(1.73)	(2.24)[b]	(2.56)[b]	(2.96)[a]	(4.01)[a]	(5.65)[a]
Decile 5	1.23	1.42	1.57	1.74	2.41	3.42
	(2.23)[b]	(2.87)[a]	(3.3)[a]	(3.78)[a]	(5)[a]	(6.63)[a]
Decile 6	1.24	1.44	1.61	1.79	2.5	3.55
	(3.12)[a]	(4.04)[a]	(4.69)[a]	(5.31)[a]	(6.9)[a]	(9.06)[a]
Decile 7	1.28	1.51	1.71	1.9	2.63	3.67
	(4.57)[a]	(5.85)[a]	(6.67)[a]	(7.41)[a]	(9.27)[a]	(11.69)[a]
Decile 8	1.28	1.5	1.69	1.87	2.54	3.39
	(5.75)[a]	(7.27)[a]	(8.43)[a]	(9.36)[a]	(11.48)[a]	(13.68)[a]
Decile 9	1.14	1.24	1.31	1.38	1.62	1.93
	(4.77)[a]	(5.66)[a]	(6.06)[a]	(6.5)[a]	(7.18)[a]	(7.87)[a]
Decile 10	0.95	0.93	0.91	0.9	0.87	0.9
	(-1.37)	(-1.48)	(-1.57)	(-1.44)	(-1.44)	(-0.86)
Full Sample	*1.25*	*1.44*	*1.59*	*1.76*	*2.4*	*3.38*
	(2.73)[a]	*(3.42)*[a]	*(3.95)*[a]	*(4.51)*[a]	*(5.98)*[a]	*(8.03)*[a]

Notes: [a] The corresponding variance ratios are statistically different from 1 at the 5 per cent level when compared with the SMM critical value of 2.632

[b] Inference error in which the test statistics are significant according to the standard normal critical value but are jointly insignificant

Separation of the sample into four sub-samples is performed in order to determine if the results from the joint variance ratio test are consistent across all sample time periods. The results for each time period are reported in Table 6, Panels A to D. Applying the joint variance ratio test to the first two time periods, 1965–1974 (Panel A) and 1975–1986 (Panel B), there is almost no deviation from the results using an LM variance ratio test. In each time period, all portfolios at levels of aggregated observations are significant according to the SMM critical value. Predictability is evident across all portfolios during the first two time periods.

Table 6: Multiple Variance Ratios for Continuously Compounded Daily Returns for UK Equity Returns at Various Aggregations for 10 Equally and Value-Weighted Deciles under Heteroscedastic Conditions

	Panel A						Panel B					
	Variance Ratio Test under Heteroscedastic Conditions from 1 January 1965 to 31 December 1974 Time Series Equally Weighted						Variance Ratio Test under Heteroscedastic Conditions from 1 January 1975 to 31 December 1985 Time Series Equally Weighted					
	Number (q) of base observations aggregated to form variance ratio						*Number (q) of base observations aggregated to form variance ratio*					
	2	**3**	**4**	**5**	**10**	**20**	**2**	**3**	**4**	**5**	**10**	**20**
Decile 1	1.37	1.7	1.97	2.2	3.35	5.18	1.21	1.38	1.51	1.61	1.92	2.59
	(7.66)[a]	(9.77)[a]	(11.22)[a]	(12.37)[a]	(17.5)[a]	(22.79)[a]	(5.2)[a]	(6.62)[a]	(7.16)[a]	(7.42)[a]	(7.76)[a]	(9.82)[a]
Decile 2	1.46	1.83	2.13	2.4	3.59	5.32	1.35	1.6	1.77	1.87	2.15	2.87
	(6.69)[a]	(8.62)[a]	(10.04)[a]	(11.29)[a]	(15.52)[a]	(19.3)[a]	(8.27)[a]	(9.25)[a]	(9.4)[a]	(9.19)[a]	(8.66)[a]	(10.78)[a]
Decile 3	1.44	1.77	2.04	2.28	3.26	4.86	1.36	1.63	1.81	1.92	2.16	2.67
	(7.96)[a]	(9.58)[a]	(10.65)[a]	(11.56)[a]	(14.57)[a]	(18.27)[a]	(9.04)[a]	(10.1)[a]	(10.24)[a]	(10.06)[a]	(9.15)[a]	(9.96)[a]
Decile 4	1.43	1.74	1.97	2.17	3.11	4.51	1.41	1.68	1.86	1.97	2.23	2.64
	(6.71)[a]	(8.17)[a]	(9.05)[a]	(9.89)[a]	(13.04)[a]	(15.95)[a]	(8.98)[a]	(9.75)[a]	(9.83)[a]	(9.65)[a]	(8.83)[a]	(9.32)[a]
Decile 5	1.42	1.71	1.92	2.1	2.86	3.96	1.38	1.64	1.84	1.97	2.34	2.8
	(7.48)[a]	(8.78)[a]	(9.54)[a]	(10.15)[a]	(12.44)[a]	(14.62)[a]	(8.83)[a]	(9.87)[a]	(10.17)[a]	(10.17)[a]	(10.13)[a]	(10.77)[a]
Decile 6	1.42	1.71	1.91	2.07	2.8	3.91	1.37	1.62	1.81	1.95	2.34	2.82
	(7.63)[a]	(8.92)[a]	(9.5)[a]	(9.99)[a]	(12.2)[a]	(14.59)[a]	(8.42)[a]	(9.17)[a]	(9.44)[a]	(9.53)[a]	(9.86)[a]	(10.75)[a]
Decile 7	1.4	1.67	1.85	1.99	2.64	3.64	1.36	1.58	1.75	1.85	2.15	2.54
	(7.4)[a]	(8.59)[a]	(9.12)[a]	(9.56)[a]	(11.36)[a]	(13.45)[a]	(8.87)[a]	(9.56)[a]	(9.7)[a]	(9.57)[a]	(9.27)[a]	(9.63)[a]
Decile 8	1.39	1.65	1.83	1.98	2.64	3.64	1.31	1.5	1.65	1.74	2	2.31
	(7.37)[a]	(8.43)[a]	(8.99)[a]	(9.47)[a]	(11.42)[a]	(13.51)[a]	(7.61)[a]	(8.31)[a]	(8.57)[a]	(8.51)[a]	(8.26)[a]	(8.31)[a]
Decile 9	1.34	1.55	1.68	1.8	2.31	3.05	1.24	1.35	1.43	1.48	1.61	1.79
	(7.23)[a]	(8.04)[a]	(8.37)[a]	(8.7)[a]	(10.12)[a]	(11.47)[a]	(7.66)[a]	(7.73)[a]	(7.7)[a]	(7.4)[a]	(6.37)[a]	(5.96)[a]
Decile 10	1.25	1.37	1.43	1.48	1.7	2.11	1.14	1.2	1.25	1.3	1.37	1.45
	(7.41)[a]	(7.55)[a]	(7.15)[a]	(7.02)[a]	(6.96)[a]	(7.8)[a]	(5.51)[a]	(5.52)[a]	(5.69)[a]	(5.68)[a]	(4.74)[a]	(3.91)[a]
Full S[a]mple	1.43	1.72	1.92	2.11	2.91	4.12	1.38	1.63	1.8	1.92	2.25	2.72
	(7.15)[a]	(8.39)[a]	(9.08)[a]	(9.72)[a]	(12.17)[a]	(14.64)[a]	(8.92)[a]	(9.8)[a]	(10.09)[a]	(10.06)[a]	(9.81)[a]	(10.51)[a]

(Continued)

Table 6: (Continued)

	Panel C						Panel D					
	Variance Ratio Test under Heteroscedastic Conditions from 1 January 1986 to 31 December 1996 Time Series Equally Weighted						**Variance Ratio Test under Heteroscedastic Conditions from 1 January 1997 to 31 December 2007 Time Series Equally Weighted**					
	Number (q) of base observations aggregated to form variance ratio						*Number (q) of base observations aggregated to form variance ratio*					
	2	**3**	**4**	**5**	**10**	**20**	**2**	**3**	**4**	**5**	**10**	**20**
Decile 1	1.17	1.29	1.40	1.54	2.06	3.04	1.2	1.37	1.53	1.68	2.32	3.35
	(1.53)	(1.90)	(2.23)[b]	(2.67)[a]	(3.72)[a]	(5.59)[a]	(5.1)[a]	(6.52)[a]	(7.7)[a]	(8.73)[a]	(11.68)[a]	(14.93)[a]
Decile 2	1.14	1.27	1.37	1.51	2.01	2.95	1.25	1.46	1.64	1.81	2.46	3.54
	(0.87)	(1.23)	(1.42)	(1.74)	(2.43)[b]	(3.69)[a]	(4.41)[a]	(5.53)[a]	(6.19)[a]	(6.82)[a]	(8.81)[a]	(11.04)[a]
Decile 3	1.13	1.24	1.33	1.47	1.96	2.84	1.17	1.32	1.45	1.57	2.11	2.93
	(0.75)	(1.02)	(1.18)	(1.48)	(2.23)[b]	(3.4)[a]	(3.96)[a]	(5.08)[a]	(5.89)[a]	(6.57)[a]	(9.2)[a]	(11.31)[a]
Decile 4	1.18	1.33	1.44	1.59	2.17	3.15	1.2	1.35	1.5	1.63	2.18	3.03
	(1.27)	(1.65)	(1.88)	(2.22)[b]	(3.1)[a]	(4.47)[a]	(4.21)[a]	(5.15)[a]	(6.01)[a]	(6.65)[a]	(9)[a]	(11.42)[a]
Decile 5	1.21	1.38	1.53	1.71	2.4	3.47	1.28	1.47	1.63	1.79	2.44	3.43
	(1.49)	(1.98)[b]	(2.30)[b]	(2.70)[a]	(3.73)[a]	(5.07)[a]	(5.5)[a]	(6.36)[a]	(7)[a]	(7.7)[a]	(9.91)[a]	(12.2)[a]
Decile 6	1.22	1.42	1.59	1.79	2.54	3.7	1.26	1.45	1.62	1.77	2.43	3.32
	(1.88)	(2.52)[b]	(2.98)[a]	(3.46)[a]	(4.65)[a]	(6.32)[a]	(5.61)[a]	(6.84)[a]	(7.71)[a]	(8.56)[a]	(11.47)[a]	(13.65)[a]
Decile 7	1.26	1.49	1.69	1.9	2.73	3.93	1.3	1.53	1.72	1.9	2.56	3.48
	(2.27)[b]	(3.04)[a]	(3.54)[a]	(4.05)[a]	(5.34)[a]	(7.04)[a]	(7.31)[a]	(8.84)[a]	(9.76)[a]	(10.59)[a]	(12.83)[a]	(14.59)[a]
Decile 8	1.3	1.52	1.71	1.92	2.67	3.67	1.26	1.48	1.66	1.83	2.45	3.2
	(3.03)[a]	(3.82)[a]	(4.42)[a]	(5)[a]	(6.25)[a]	(7.74)[a]	(6.9)[a]	(8.64)[a]	(9.88)[a]	(10.86)[a]	(13.59)[a]	(15.14)[a]
Decile 9	1.14	1.24	1.32	1.41	1.74	2.17	1.13	1.23	1.3	1.37	1.57	1.85
	(2.13)[b]	(2.64)[a]	(3.07)[a]	(3.48)[a]	(4.52)[a]	(5.64)[a]	(4.15)[a]	(4.85)[a]	(5.04)[a]	(5.29)[a]	(5.5)[a]	(5.83)[a]
Decile 10	0.8	0.71	0.69	0.7	0.7	0.75	1.02	1.02	1.00	1	0.95	0.97
	(-2.07)[b]	(-2.21)[b]	(-2.04)[b]	(-1.85)	(-1.51)	(-1.08)	(0.69)	(0.59)	(0.07)	(-0.04)	(-0.6)	(-0.25)
Full S[a]mple	1.22	1.38	1.52	1.69	2.32	3.3	1.3	1.52	1.7	1.88	2.56	3.56
	(1.55)	(1.93)	(2.24)[b]	(2.64)[a]	(3.64)[a]	(5.05)[a]	(6.15)[a]	(7.45)[a]	(8.3)[a]	(9.11)[a]	(11.59)[a]	(13.83)[a]

Notes: [a] The corresponding variance ratios are statistically different from 1 at the 5 per cent level when compared with the SMM critical value of 2.632

[b] Inference error in which the test statistics are significant according to the standard normal critical value but are jointly insignificant

Only the third time period fails to provide convincing evidence of predictability in UK equities. This period, 1986–1997, reports dramatically different results to those of the first two time periods. The results show that every portfolio, with the exception of the eight decile, has incorrectly significant LM variance ratios when utilising the SMM critical value. The seventh and ninth deciles report significant observations for a number of variance ratios; however, only the eighth decile has significant variance ratios across all aggregated observations. Evidence of predictability significantly decreases in this third time period.

Finally, in the most recent time period (1997–2007), reported in Panel D, all portfolios, with the exception of Decile 10, exhibit statistically significant signs of predictability. As with the LM variance ratio tests, Decile 10 variance ratios are statistically insignificant from zero using the CD multiple variance ratio test.

That the returns of different decile portfolios in different periods have statistically insignificant variance ratios is not surprising. Lo and MacKinlay (1988) report similar findings when their sample is disaggregated. As individual returns contain company-specific noise, this makes it difficult to detect the presence of predictable components. Aggregating the stock returns into portfolios filters much of the noise, evidenced by the consistent results for the full sample portfolio across time periods However, at the decile level of aggregation some noise is likely to remain.

Overall, the evidence we present in this section of the paper suggests that equity returns do appear to be predictable. The evidence is strongest when predictability is measured using simple autocorrelation tests and LM variance ratios. When we estimate the more stringent CD multiple variance ratios, the evidence is weaker, but further analysis shows that this is driven by the 1986–1996 period, where for all tests there is considerable less evidence of predictability.

We also find considerable cross-sectional and cross-longitudinal variance in the results of our predictability measures. Evidence of predictability is strongest in the 1965–1985 and 1997–2007 periods. In the 1986–1996 period the results are less clear. Cross-sectional evidence also shows that in some time periods the variance ratios are larger for small capitalisation stocks, whereas in others, it is the largest capitalisation stocks which appear most predictable.

Our evidence of predictability in UK equity returns is consistent with prior evidence for UK equities (Lovatt et al., 2007) and UK indices (Belaire-Franch and Opong, 2005). However, it is worth highlighting that the evidence for UK indices is mixed, with both Malliaropulos (1996) and Patro and Wu (2004) finding evidence supporting RWT in the UK, though both studies are less comprehensive than Belaire-Franch and Opong (2005).

These results raise implications for both researchers and practitioners. Though recent financial market events, such as the dot-com and housing bubbles, have cast doubt on RWT and EMH, they remain a cornerstone of finance theory. Our results provide evidence that would suggest a rejection of RWT. However, we do not consider transaction costs as part of our analysis so we can draw fewer conclusions relating to EMH.

From the perspective of a practitioner, the results should provide a guide to highlight the pitfalls of statistics-based trading strategies. By focusing on one group, such as large capitalisation stocks, in isolation, a practitioner will likely encounter periods of low profitability, perhaps due to unsystematic risks. Alternatively, taking a more diversified approach with a portfolio constructed across both small and large capitalisation stocks will likely insulate against these cross-sectional variations in predictability, taking advantage of systematic predictability. Another concern for the practitioner should be the longitudinal variation in predictability. In our analysis, the sub-sample from 1986 to 1996 was a period of relatively weak return predictability. Put simply, performance is likely to vary considerably over time.

CONCLUSION

This paper has clear practical implications for investors in equity market neutral hedge funds and managers pursuing statistical arbitrage strategies in equity markets. Despite the large losses reported for this group in 2007 and 2008, the strategies are based upon a sound premise – equity returns are, to a degree, predictable. Irrespective of measure, our results show strong evidence of return predictability.

The evidence reported in this paper, using the CD multiple variance ratio, our most stringent test, shows that in the early time periods, 1965–1974 and 1975–1985, all firm size deciles exhibit return predictability. It is reasonable to postulate that statistical arbitrage profitability in such an environment would be relatively high. However, in the 1986–1996 time period the results are quite different. Only in the large stock deciles (specifically Deciles 7–9) is return predictability evident. Again, we can deduce that this environment would be difficult for fund managers. Finally, in the 1997–2007 period, the environment becomes more favourable, and returns are predictable for the majority of stocks.

Because return predictability is both cross-sectionally and time varying, practitioners must be very flexible. These results demonstrate the challenges for a manager who bases a strategy on return predictability.

ENDNOTES

1 The financial support of the Irish Research Council for the Humanities and Social Sciences (IRCHSS) is gratefully acknowledged. We are also grateful to two anonymous referees for comments which have greatly improved the paper.

2 Barclay Group estimates: <http://www.barclaygrp.com/indices/ghs/mum/Equity_Market_Neutral.html>.

3 We calculate the stock returns adjusted for dividends from the stock return index, *RI*, provided by Datastream. Returns are calculated as:

$$\frac{RI_t}{RI_{t-1}}$$

4 The concerns which have been raised by Ince and Porter, 2006) amongst others about data errors in Datastream are mainly concentrated amongst small stocks and/or low price stocks. Dividing our sample into deciles provides a natural control for any remaining errors as these stocks will be mainly grouped in decile 1. Readers concerned about the effect of these errors should focus their attention on the results for deciles 2 to 10.

5 Holidays are omitted from the sample. If a stock return is missing for a particular day it is omitted from the aggregate and decile portfolio for that day.

6 As an additional robustness test, we also form value-weighted portfolios. The results for these portfolios are in line with the equal weighted results and are available from the authors on request.

7 SMM critical values can be taken from the standard normal z table; the 5 per cent SMM critical value is the z-value leaving an upper tail area of $0.5[1 - (1 - 0.05)^{1/k}]$ where k is the number of sampling intervals.
Upper Tail: 05 * (1 - (1 - 0.05) ^ (1/6)) = 0.004256
Lower Tail: 1 - 0.004256 = 0.99574
$\alpha = \pm 2.632$

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