WARWICK

Department of Economics

Undergraduate coursework evaluation form

Module code 331 | Coursework item number

Student's name *or* ID number 37976 | Coursework item mark 76

Tutor's name IW | Date 10/5

Key: Your coursework can be evaluated using *some* or *all* of the criteria below. In most cases a grade is returned which shows that the criterion has been met to a standard described as follow

A	❑ excellent	*equivalent to a mark of*	70 or more
B+	❑ good		60–69
B–	❑ satisfactory		50–59
C	❑ needs attention		40–49
D	❑ unsatisfactory		39 or less
NA	❑ not applicable		

Structure

Is there an introduction? Yes ☑ No ❑ N
- if yes, does it usefully explain the argument? A ☑ B+ ❑ B– ❑ C ❑ D ❑ N
Is the order of the argument clearly explained? A ☑ B+ ❑ B– ❑ C ❑ D ❑ N
Does the coursework avoid significant gaps or omissions? A ☑ B+ ❑ B– ❑ C ❑ D ❑ N
Does the coursework avoid significant irrelevant material? A ☑ B+ ❑ B– ❑ C ❑ D ❑ N
Is there a conclusion? Yes ☑ No ❑ N
- if yes, does it accurately reflect the argument? A ☑ B+ ❑ B– ❑ C ❑ D ❑ N

Is the coursework of appropriate length? Too short ❑ About right ☑ Too long ❑ N

Analysis

Is there appropriate use of
- significant concepts? A ☑ B+ ❑ B– ❑ C ❑ D ❑ N
- analytical models? A ☑ B+ ❑ B– ❑ C ❑ D ❑ N
- quantitative techniques? A ☑ B+ ❑ B– ❑ C ❑ D ❑ N
- graphs and diagrams? A ☑ B+ ❑ B– ❑ C ❑ D ❑ N
Is relevant evidence used to test hypotheses? A ❑ B+ ☑ B– ❑ C ❑ D ❑ N
Are explanations clear and complete? A ☑ B+ ❑ B– ❑ C ❑ D ❑ N

Sources

Does the coursework demonstrate wide reading? A ☑ B+ ❑ B– ❑ C ❑ D ❑ N
Does the coursework avoid undue reliance on lecture notes? A ☑ B+ ❑ B– ❑ C ❑ D ❑ N
Are arguments, quotes, and facts properly referenced? A ❑ B+ ☑ B– ❑ C ❑ D ❑ N
Are items listed in the bibliography used effectively? A ☑ B+ ❑ B– ❑ C ❑ D ❑ N

Style and presentation

Does the coursework avoid
- spelling mistakes? Good ☑ Needs attenti
- mistakes of grammar? Good ☑ Needs attenti
- overlong or unfocused paragraphs? Good ☑ Needs attenti
Is the coursework clearly legible? Good ☑ Needs attenti

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Other comments: general evaluation
Good examination of dynamic properties of the FTSE. Realises that there is an important economic principle at stake. Good work
Structure
Good
Analysis
Impressive
Sources
Good
Presentation
Good

AN ECONOMIC WALK IN THE CITY

ABSTRACT

The FTSE 100 returns were investigated over the 10-year period, 1990 – 1999. Economic variables were considered as a method of predicting stock market returns. The price earnings ratio, retail price index, consumer expenditure, UK and USA interest rate were found to be significant. The price earnings ratio, RPI and UK interest rate possessed negative coefficients, consumer spending and the US interest rates positive ones.

CONTENTS:

INTRODUCTION

The existence of corporations can be traced back to Roman Times ever and since then people have sought to invest in these companies first through loans then using more complex securities traded on stock exchanges. As soon as people invested in companies, they also attempted to predict the likelihood of getting their money back and any return on the investment. Novel approaches have been suggested from lunar cycles to sunspots. Over the last 50 years there have been great advances in strategic investment, most notably Harry Markowitz portfolio selection, William Sharpe's capital asset pricing model and the arbitrage pricing theory[1].

The capital asset pricing model simply states that a securities return can be calculated using only the return on a risk free asset, such as a Treasury bill (R^F) and the market portfolio (R^M)

$$R_k = R^F + \beta_k(R^M - R^F) \qquad k = i\ ,\ j......n \qquad \beta_i > \beta_l$$

Where beta denotes the sensitivity of security K to market movements. A high positive beta implies that, when the return on the market portfolio increases, so does the return on asset i, more so than on asset j which has a lower beta. If the beta of asset K is negative, a rise in the market portfolio produces a fall in the return on K. If we can predict the future performance of the market portfolio, it becomes possible to predict future returns on individual securities. This information can be used to make or protect portfolio returns either by buying or selling individual securities or by purchasing options[2]. The aim of this assessment is to use the FTSE 100 as a proxy for the market portfolio and predict its performance over the 10-year period form January 1990 to January 2000.

THEORIES APPLIED TO FINANCIAL TIME SERIES

(A) The Random Walk

The random walk hypothesis is a statement that price changes are entirely random. Yesterday's price is the best estimate of today's, so we consequently cannot predict future stock market returns. Often a "trend" term (T) is included, implying that the most accurate forecast of tomorrows price is today's price plus an estimate of the long run average price change.

$$P_t = \beta_P P_{t-1} + (\beta_T T) + e_t \qquad \text{Ho: } \beta_P = 1 \text{ and } COV(e_i,e_j|X_i,X_j) = 0$$

If the null hypothesis true:

$P_t - P_{t-1} = (\beta_T T) + e_t$ and there is no serial correlation

Serial correlation occurs when past error term's effects today's price. If it can be proved that there is serial correlation, it becomes possible to predict market movements and the random walk is disproved. We can detect serial correlation using the following Wald Test test:

$$P_t = \beta_1 P_{t-1} + \phi_1 e_{t-1} + \phi_2 e_{t-2} + \phi_3 e_{t-3} .....\phi_\rho e_{t-\rho}$$

$$\text{Ho: } \phi_1 = \phi_2 = \phi_3 = ... = \phi\rho = 0$$

$$F = \frac{(RSS^R - RSS^U) / P}{RSS^U / (n-k-p)} \sim F_{p,n-k-p}$$

Where ρ = 1, 4 or 12 for annual, quarterly of monthly data

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[1] Ross (1976)

[2] Although original CAPM theory suggests investors should hold a proportion of the total market portfolio rather than a portfolio of their own choice. Realistically however, portfolios do not follow exactly the market portfolio, some may focus on an industry, capital growth or income.

(b) ARCH and GARCH Models

Leading on from the random walk are the ideas of autoregressive conditional heterscedastic (ARCH) and Generalised ARCH (GARCH) models. First developed by Engle in 1982, they aim to explain the volatility clustering (Clustering of large and small observations) often found in financial time series. This volatility clustering leads to non-constant variances over time (heterscedasticity). ARCH and GARCH models generally take the form:

$$\mathbf{e}_t = \alpha_0 + \alpha_1 \mathbf{e}^2_{t-1} + \alpha_2 \mathbf{e}^2_{t-2} \dots\dots\dots + \alpha_p \mathbf{e}^2_{t-1p} + \mathbf{V}_t \qquad \textbf{ARCH(P)}$$

$$\mathbf{e}_t = \alpha_0 + \alpha_1 \mathbf{e}^2_{t-1} + \alpha_2 \mathbf{e}^2_{t-2} \dots\dots\dots + \alpha_p \mathbf{e}^2_{t-1p} + \gamma_1 \delta_{t-1} + \dots\dots \gamma_p \delta_{t-p} + \mathbf{V}_t \qquad \textbf{GARCH (P,G)}$$

(c) Efficient Markets

Another concept applied to stock market prices is the efficient markets hypothesis, that prices reflect fully all-available information. If price immediately reflect this information and new information is unpredictable, there is no opportunity to forecast future returns. In the case of the random walk, the only relevant information is that of yesterday's price. If the random walk is correct, this does not imply that the market is inefficient, rather that it is at least weak form efficient. Weak form efficiency implies that investors cannot make excess returns using past prices as a guide. If the market is semi-strong efficient, investors cannot earn excess returns using any publicly available information. So for example, macroeconomic variables and past prices cannot be used for forecasting.

In the 1960's most academics, most notably Fama (1965 and 1970) gave strong evidence that market prices reflected all available information, so forecasting was futile. However, over the last two decades opinions have change, for example Fama and French (1989) found that stock returns could be predicted using dividend yields, term spreads and default spreads. Other authors such as Roosma (1995) have found similar results when applying dividend yields, price earnings ratio and the federal fund rate to the Dow Jones Average.

VARIABLES, EXPLANATIONS AND EXPECTATIONS

The main aim of this assessment is to investigate returns of the FTSE 100 as a proxy for the market portfolio and to determine whether these returns are predictable. I hope to prove that macroeconomic variables can be used to predict future monthly returns over the 10 year period 1990:01 – 2000: 01 and if possible to apply them to notable stock market crashes. Monthly returns were used to reduce the amount of adjustment need for quarterly data. Because monthly returns were used, I have chosen not to apply an ARCH or a GARCH model as previous studies have found that using monthly data reduces the amount of heterscedasticity contained in the data.

The model used: $\mathbf{P}_t - \mathbf{P}_{t-1} = \beta_1 + \Sigma\beta_j \,\mathbf{MACRO} + \mathbf{V}_t$

The variables chosen and the reasons for inclusion as well as any adjustments needed are given on the next pages

Gross Domestic Product, Consumer Spending and Investment

GDP is used in this study as a measure of the health of the UK economy. An increase in GDP at or above the average rate implies a strong rate of growth of UK company earnings, raising the FTSE. I would therefore expect a positive coefficient on GDP. There is some debate however as to whether the growth of the economy precedes changes in the FTSE or investor expectations of future growth pre-empt the release of GDP figures. If this was the case, the FTSE would be used as a lead indicator for GDP and not visa versa.

Closely related to GDP are consumption and investment. The effect of investment on company earnings can be looked at in two parts. In the short term, investment reduces the availability of earnings available to shareholders, perhaps depressing the share price. In the long run investment should make firms more efficient or produce new goods that increase turnover and so returns. So, in the short run it is possible that investment carries a negative coefficient and in the long run positive.

If UK consumption increases, certaris paribus, corporate turnover and therefore earnings increase, leading to a rise in the FTSE. I would therefore expect a positive coefficient on consumption. Of course if some of this expenditure is focused on imports, rather than UK companies, the coefficient will be smaller.

Exports and Imports

Exports create production and income for UK firms, increasing returns. Imports steal market share and reduce returns. I therefore expect a negative coefficient on imports and a positive coefficient on exports. Higher net exports are a signal of increasing UK competitiveness, either UK goods becoming relatively cheaper (depreciation of the exchange rate) or by improved design and quality. A depreciation of the exchange rate may be caused by a falling UK interest rate (Uncovered interest rate parity) or a lower rate of inflation in the UK (Purchasing power parity).

$$\overset{o}{e} = R - R^f \qquad \text{(Uncovered interest rate parity)}$$

$$e = \frac{P^f}{P} \qquad \text{(Purchasing power parity)}$$

The uncovered interest rate parity assumes that if the UK interest rate is lower than the world interest rate, capital flows out of the country reducing the demand for sterling causing the exchange rate to depreciate. The purchasing power parity states that if UK inflation is higher than foreign inflation, exchange rates adjusts appropriately to prevent a loss of competitiveness.

Prices

Both the retail price index and the producer price index were investigated as measures of inflation. A negative coefficient was expected on the PPI because if producers face increasing costs cereris paribus, profits and in turn returns, fall.

The expected sign on the retail price index is a little more complex. Firstly, if we take the RPI (not taking into account mortgage repayments) as the best indicator of underlying inflation, an increase in inflation reduces the "real" growth rate of other variables such as GDP. This would have a negative effect on returns. Secondly, if UK prices increase relatively against its competitors, net exports will fall unless a correction in the exchange rate occurs, again having a negative effect on return. Alternatively, increasing inflation decreases UK real interest rates, reducing the burden of debt on firms, increasing returns. It also increases the disposable income available to consumers in debt. If borrowers have a higher propensity to consume than savers, this will increase consumer having a positive effect on returns.

Interest Rates and Foreign Price Indexes

The interest rates considered were 3 month t-bills. As I have previously stated a reduction in UK interest rates relative to foreign interest rates may, through the uncovered interest rate parity cause the exchange rate to fall, boosting net exports and increasing returns. Secondly, cutting UK interest rates may also increase consumer spending and reduces firms debt burden, again increasing returns. Thirdly, falling interest rates reduces the rate of return on bonds, this may cause investors to swap bonds for equities, increasing the price of the FTSE. For this reason I would expect a negative coefficient on UK interest rates.

I have chosen USA interest rates as the best indicator of foreign interest rates being one of the UK's largest individual trading partners and probably the most influential countries world wide. Because of UPI, I would expect a positive coefficient on USA interest rates,

If the USA stock market falls, it often appears that the FTSE follows it. Why this is so is complex involving not only the normal trading interactions of the USA and UK but also investor expectations. If the S&P500 falls, it may be an indication of a lack of confidence in the USA economy which, because of links with the UK economy, triggers uncertainty in the UK and the FTSE falls. I would therefore expect a negative coefficient on the S&P500.

Unemployment and Bankruptcy

Because of the multicollinearity problems which will be outlined later, unemployment and the bankruptcy rates may be better indicators of the state of the economy than GDP. An increase in unemployment and bankruptcy rate could indicate a movement into recession and falling corporate earnings. I would therefore expect a negative coefficient on unemployment and bankruptcy rates.

Dividend Yield and Price Earnings Ratio

The availability of price earnings and dividend yield data is a relatively recent phenomenon, data only being available since 1993 which curtails the sample size available for forecasting the FTSE. The PE and DY[3] ratio have often been investigated in relation to returns on an individual stock basis under the arbitrage pricing theory and, more recently in relation to American stock market indexes by Zweig (1990) and Roosman (1995).

I would expect a negative coefficient on the PE ratio. This ratio is the number of years earnings investors are willing to purchase at the current share price. The PE ratio is often used as a method of assessing how cheap a stock is, a high PE ratio denoting an expensive stock and a low ratio an inexpensive one. If the PE ratio is applied to the FTSE, we can see that a rise in the PE ratio caused by a fall in earnings in relation to stock prices implies FTSE is now over valued, prompting a fall in the stock market price.

I would expect a positive coefficient on the dividend yield. The dividend yields indicates not only the annual return on an investment, but may also indicate the ability of a firm to generate future profits. If dividend policy is used by managers to signal future expected cash flows, an increasing dividend yield implies higher future cash flows and greater earnings. Investors willing to purchase this future income will drive the price of share up. It is also likely that the effect of the dividend yield lags behind that of the price earnings ratio because earnings are declared before final dividends are announced.

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[3] $PE = \frac{\text{Share Price}}{\text{Earnings Per Share}}$ $DY = \frac{\text{Gross Dividnend}}{\text{Market Value of Shares}}$

ADJUSTMENTS

Multicolliniearity

Many of the variables used to predict the FTSE 100 will be subject to multicollinearity, that is that they are linearly related to each other. If multicollinearity is perfect, the regression coefficients are indeterminable and the standard errors infinite. This is unlikely, but, even if variables are only highly correlated, the regression errors will posses high variance and covariance leading to imprecise estimates and a higher probability of accepting the zero-null hypothesis. The multicollinearity problem can be tackled in two ways. Firstly if theory suggests that two variables, such as the ones outlined below, should be highly correlated, the model can be adjusted accordingly using hypothesis testing:

$$R = \ldots\ldots + \beta_y Y + \beta_c C + \beta_I I + \beta_x X - \beta_m M + \beta_G G - \beta_T T + e \qquad \textbf{but} \quad Y = C + I + (X-M) + (G-T)$$

If it is proved that $\beta_y = \beta_c\alpha_c + \beta_I\alpha_I + \beta_x\alpha_X - \beta_m\alpha_m + \beta_G\alpha_G - \beta_T\alpha_T$

$$R = \ldots\ldots\ldots\ldots\ldots \beta_{Y^*}(\alpha_c C + \alpha_I I + \alpha_X X - \alpha_m M + \alpha_G G - \alpha_T T) + e$$

If however, there is no theoretical reason why two variables should be related, we must hope that the gradual removal of all insignificant variables removes one or other of the correlated variables without adversely affecting R^2.

Quarterly Data

All economic data was measured at current prices and seasonally adjusted by Datastream. For quarterly data such as GDP the following adjustments were made:

Date	LGDP	dLGDP	Dummy	DLGDP
1990 01	Missing	Missing	0	0
1990 02	Missing	Missing	0	0
1990 03	X_1	X_1-X_0	1	X_1-X_0
1990 04	Missing	Missing	0	0
1990 05	Missing	Missing	0	0
1990 06	X_2	X_2-X_1	1	X_2-X_1
1990 07	Missing	Missing	0	0
1990 08	Missing	Missing	0	0

This means that the change in GDP is only taken into account when the announcement is made and is otherwise assumed to be zero. Although GDP obviously varies though out the quarter, this allows easy and relatively accurate interpretation of the model, especially when predicting future returns.

Logs

All variables except interest and unemployment rates were logged. This implies that all coefficients are elasticity's and a one percent increase in, for example GDP increases returns by β percent.

Non Stationarity

When I estimate a model I assume that the variables are stationary, that is that there is no trend involved, however many economic variables are non stationary such as GDP[4]. If FTSE returns are increasing over time any series with an upward trend will explain the data, even if there is no real relationship at all. For that reason, instead of expressing returns as a function of these trending variables, instead I regress returns against the difference.

$$LP_t - LP_{t-1} = \ldots\ldots\ldots + \beta_Y LY_{t-1} \ldots\ldots + V_t \qquad \textbf{(Non stationary)}$$
$$LP_t - LP_{t-1} = \ldots\ldots\ldots + \beta_Y (LY_{t-1} - LY_{t-2}) \ldots\ldots + V_t \qquad \textbf{(Stationary)}$$

[4] See appendix for graphs and non stationary variables

REGRESSION MODELS AND RESULTS

The Random Walk

The following model was estimated:

$$LFTSE100_t = \beta_0 + \beta_1 LFTSE100_{t-1} + e_t$$

A trend term was not included as examination of returns over the ten-year period 1990:01 – 2000:00 concluded that the mean was not significantly different from zero, implying that there is no growth trend.

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	-0.0098580	0.10920	-0.090	0.9284	0.0002
L(FTSE100)_1	1.0039	0.030688	32.713	0.0000	0.9562

R^2 = 0.956215 F(1,49) = 1070.1 [0.0000] \sigma = 0.0148419 DW = 2.25 RSS = 0.01079387476

$H_0: \beta_1 = 1$
$H_1: \beta_1 \neq 1$

$$t = \frac{1.0039 - 1}{0.030688} = 0.127 \qquad t_{49,1}^{0.01} = 2.403$$

As you can see from the t-statistic, we cannot reject the null hypothesis that β_1 is equal to one. Next, a regression was run of the FTSE 100 against it's lagged value and the error term lagged 12 times[5] (Monthly Data) in order to detect serial correlation.

$$LFTSE_t = \beta_0 + \beta_1 LFTSE_{t-1} + e_t \qquad \text{(Restricted)}$$
$$LFTSE_t = \beta_0 + \beta_1 LFTSE_{t-1} + \phi_1 e_{t-1} + \phi_2 e_{t-2} + \phi_3 e_{t-3} \ldots\ldots \phi_p e_{t-12} + v_t \qquad \text{(Unrestricted)}$$

$$Ho: \phi_1 = \phi_2 = \phi_3 = \ldots\ldots\ldots = \phi_{12} = 0$$

$$F = \frac{(RSS^R - RSS^U) / P}{RSS^U / (n-k-p)} = \frac{(0.01079 - 0.00456)/12}{0.00456/(50-1-12)} = 4.212 \qquad F_{12,37}^{0.01} = 2.74$$

With an F- Statistic of 4.212 we reject the null hypothesis and there is evidence of serial correlation. Serial correlation can be caused by misspecified dynamics or omitted relevant variables.

$$LFTSE_t = \beta_0 + \beta_1 LFTSE_{t-1} + e_t \qquad \text{(False)}$$
$$LFTSE_t = \beta_0 + \beta_1 LFTSE_{t-1} + \beta_2 LFTSE_{t-2} \ldots\ldots + \beta_k LFTSE_{t-k} \qquad \text{(True - If misspecified dynamics)}$$
$$LFTSE_t = \beta_0 + \beta_1 LFTSE_{t-1} + \Sigma\beta_j Z_{t-k} \qquad \text{(True – If omitted relent variable)}$$

By the inclusion of either more lags of the FTSE or macroeconomic variables it becomes possible to forecast future movements of the FTSE. For this assignment, I will concentrate only on the inclusion of omitted relevant variables.

INCLUDING MACROECONOMIC VARIABLES

The macroeconomic variables outlined previously were regressed[6] against stock market returns in their lagged form, except dividend yield which were also regressed for the current time period, the reason for this will explained later.

Model 1[7]

$$\begin{aligned} LFTSE_t - LFTSE_{t-1} = {} & \beta_1 + \sum_{j=1}^{3} \beta_2 \Delta LGDP_{t-j} + \sum_{j=1}^{3} \beta_3 \Delta LCON_{t-j} + \sum_{j=1}^{3} \beta_4 \Delta LINV_{t-j} + \sum_{j=1}^{3} \beta_5 \Delta LEXP_{t-j} \\ & + \sum_{j=1}^{32} \beta_6 \Delta LIMP_{t-j} + \sum_{j=1}^{3} \beta_7 \Delta LRPI_{t-j} + \sum_{j=1}^{3} \beta_8 \Delta LPPI_{t-j} + \sum_{j=1}^{3} \beta_9 LBANK_{t-j} + \sum_{j=1}^{3} \beta_{10} LUNEMP_{t-j} \\ & + \sum_{j=1}^{3} \beta_{11} LPE_{t-j} + \sum_{j=0}^{3} \beta_{12} LDY_{t-j} + \sum_{j=1}^{3} \beta_{13} UKR_{t-j} + \sum_{j=1}^{3} \beta_{14} USR_{t-j} + \sum_{j=1}^{3} \beta_{15} LS\&P_{t-j} + U_T \end{aligned}$$

The coefficient on the dividend yield was found to be significant and equal to minus one. For this reason it was subtracted from both sides to make the dependent a measure of total returns rather than just capital gains.

Model 2[8]

$$LFTSE_t - LFTSE_{t-1} + LDY_t = RETURN_t$$

$$\begin{aligned} RETURN_t = {} & \beta_0 + \sum_{j=1}^{3} \beta_1 RETURN_{t-j} + \sum_{j=1}^{3} \beta_2 \Delta LGDP_{t-j} + \sum_{j=1}^{3} \beta_3 \Delta LCON_{t-j} + \sum_{j=1}^{3} \beta_4 \Delta LINV_{t-j} \\ & + \sum_{j=1}^{3} \beta_5 \Delta LEXP_{t-j} + \sum_{j=1}^{2} \beta_6 \Delta LIMP_{t-j} + \sum_{j=1}^{3} \beta_7 \Delta LRPI_{t-j} + \sum_{j=1}^{3} \beta_8 \Delta LPPI_{t-j} + \sum_{j=1}^{3} \beta_9 LBANK_{t-j} \\ & + \sum_{j=1}^{3} \beta_{10} UNEMP_{t-j} + \sum_{j=1}^{3} \beta_{11} LPE_{t-j} + \sum_{j=1}^{3} \beta_{12} UKR_{t-j} + \sum_{j=1}^{3} \beta_{13} USR_{t-j} + \sum_{j=1}^{3} \beta_{14} LS\&P_{t-j} + U_T \end{aligned}$$

The regression of total returns found significant coefficients on GDP, exports, the PE ration, US interest rates and the lag of return. Probably because of the multicollinearity problems, fewer variables than expected were found to be significant. However gradually removing insignificant variables reduced the model to eight variables, the PE ratio (PE), retail price index (RPI), consumer spending (CON) UK interest rates (UKR) and the US interest rates (USR).

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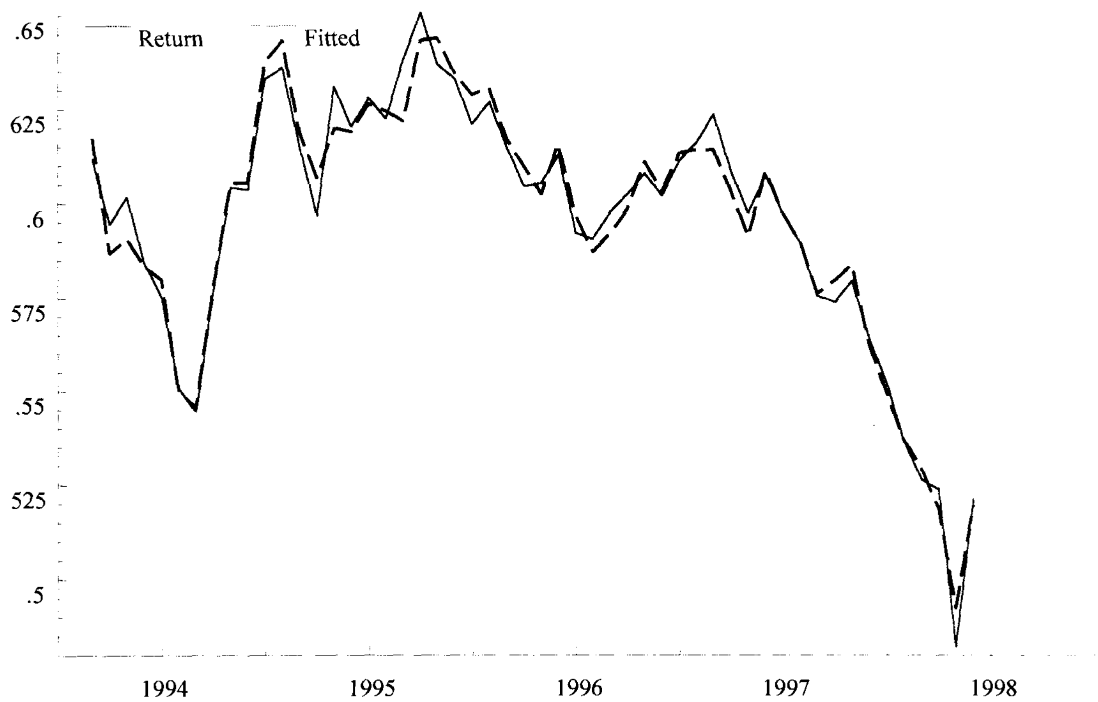
[6] See appendix for graphs of variables included in the model
[7] See appendix for regression
[8] See appendix for regression

RESULTS

$$\begin{array}{l} \textbf{Return}_t = 0.03 - 0.82\Delta LPE_{t-1} - 2.01\Delta LRPI_{t-1} - 0.96\Delta LRPI_{t-2} + \\ \qquad\qquad (0.03) \quad (0.051) \qquad (0.57) \qquad\qquad (0.57) \end{array}$$

$$\begin{array}{l} 0.54\Delta LCON_{t-1} + 1.76\Delta LCON_{t-2} - 0.001UKR_{t-1} + 0.003USR_{t-1} + 0.96Return_{t-1} + et \\ (0.53) \qquad\qquad (0.50) \qquad\qquad (0.0024) \qquad (0.0015) \qquad (0.32) \end{array}$$

Fig 1



All coefficients were found to be significant except for the coefficient on UK interest rates and the constant, which could not be removed without causing a failure of the reset test. This model passes all PC give tests and has a high R^2 at 0.975. Fig 1 shows the fitted and actual variables of the log of returns. The regression models with relative accuracy, both positive and negative movements in returns. Although it does underestimate peaks in the second halves of 1996 and 1993 and midway between 1994. This might indicate an omitted variable causes these peaks.

Long Run

Because of the involvement of a lag of the dependent variable, all explanatory variables have a short run and a long run multiplier.

$$\textbf{Return}^* = \gamma_0 + \gamma_1\Delta LPE^* + \gamma_2\Delta LRPI^* + \gamma_3{}^*\Delta LCON^* + \gamma_4 UKR^* + \gamma_5 USR^* + et$$

Where $\gamma_0 = \beta_0/(1-\beta_8)$ **and** $\gamma_3 = \beta_3/(1-\beta_8)$.

If we take the retail price index, a one percent increase in inflation leads to no change in the first month that the shock occurs in, a β_3 (-2.01) percent fall in the FTSE 100 return in the second month and in the long run a γ_2 percent fall in the return. The changes are outlined in the table on the next page.

Period	Change	Total Change (%)
0	0	0
1	β_2	-2.1
2	$\beta_2\beta_8 + \beta_3$	-2.976
3	$\beta_8(\beta_2\beta_8 + \beta_3)$	-2.86
Long Run	γ_2	-74.25

Short Run

PE Ratio: As expected, the coefficient on the PE ratio is negative. A 1% increase in the rate of growth in the PE ratio causes (in the month after the change occurs) a 0.82% fall in the FTSE. At first this may not appear to make much economic sense, because most investors would only look at a rise in the PE ratio, not an increase in the growth rate. However, if investors expect the PE ratio to be constant over time (Zero growth rate) an increase in the PE ratio (an increase in the rate of growth) implies that the FTSE is becoming overvalued and investors react negatively.

Retail Price Index: The FTSE was found to be negatively related to an increase in inflation lagged over two months. As explained before, increasing inflation has a negative effect on exports as UK goods become less competitive. However, it also reduces net debt repayments, increasing debtors disposable income and if debtors have a higher propensity to consume than savers, consumption will increase. A negative relationship implies that the effect on exports is more pronounced.

Consumer Spending: The FTSE was found to be positively related to an increase in the growth rate of consumer spending as expected. If consumption increases so does corporate turnover and returns.

UK Interest rates: The FTSE was found to be negatively related to interest rates. An increase in interest rates makes corporate borrowing more expensive, reducing earnings. It also decreases consumer spending as debtors have less disposable income available, reducing turnover. Finally because of the interest rate uncovered parity, rising UK rates in relation to foreign interest rates may result in capital inflows, causing appreciation of the exchange rate. This in turn makes UK firms un competitive and net exports fall.

US Interest rates: The FTSE was found to be positively related to US interest rates. This is probably because of two reasons, firstly UPI suggests that if US interest rates increase relative to UK interest rates, capital will flow into the US causing the exchange rate to appreciate causing net exports to fall and possibly UK net exports to increase.

Comparing the Model With the Random Walk.

We can compare this model with a random walk model using a simple F-test

$$\mathbf{Return_t = \beta_0 + \beta_1 Returnt\text{-}1 + e_t} \qquad \textbf{(Restricted)}$$

$$\mathbf{Return_t = \beta_0 + \beta_1 \Delta LPE_{t-1} + \beta_2 \Delta LRPI_{t-1} + \beta_3 \Delta LRPI_{t-2} + \beta_4 \Delta LCON_{t-1} + \beta_5 \Delta LCON_{t-2} + \beta_6 UKR_{t-1} + \beta_7 USR_{t-1} + \beta_8 Return_{t-1} + et} \qquad \textbf{(Unrestricted)}$$

Ho: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = 0$
H1: Any $\neq 0$

$$F = \frac{(RSS^R - RSS^U)/8}{RSS^U / (n-k'-1)} = \frac{(0.0084 - 0.0012)/8}{0.0012/(52-9-1)} = 31.5 \qquad F_{9,42}^{0.01} = 2.89$$

Given a F-statistic of 31.5 we reject the null hypothesis. The model including macroeconomic variables is superior to the random walk of total stock returns.

Predicted Failure Test

One of the main criticisms levied at studies investigating the effect of variables such as PE ratio's or company size is that of data mining, that is that the relationship is a coincidence and short term only. For this reason it would have been desirable to apply the model to historical stock market crashes. Unfortunately, because the PE ratio for the FTSE 100 is only priced since 1993 it is not possible. However, by estimating the model only between 1993 and 1997 it becomes possible to perform a predicted failure test. The predicted failure test tests whether the model fitted over the first n' observations also fits over the next n – n' observations (in this case 1998:01 – 1999:10).

$$R_t = \beta_0 + \beta_1 \Delta LPE_{t-1} + \beta_2 \Delta LRPI_{t-1} + \beta_3 \Delta LRPI_{t-2} + \beta_4 \Delta LCON_{t-1} + \beta_5 \Delta LCON_{t-2} + \beta_6 UKR_{t-1} + \beta_7 USR_{t-1} + \beta_8 R_{t-1} + et \qquad t = 1.....n \text{ (Restricted)}$$

$$R_t = \beta_0^1 + \beta_1^1 \Delta LPE_{t-1} + \beta_2^1 \Delta LRPI_{t-1} + \beta_3^1 \Delta LRPI_{t-2} + \beta_4^1 \Delta LCON_{t-1} + \beta_5^1 \Delta LCON_{t-2} + \beta_6^1 UKR_{t-1} + \beta_7^1 USR_{t-1} + \beta_8^1 R_{t-1} + et \qquad t = 1.....n' \text{(Unrestricted)}$$

$$Ho: \beta_0 = \beta_0^1 \quad \beta_1 = \beta_1^1 \quad \beta_2 = \beta_2^1 \quad \beta_3 = \beta_3^1 \quad \beta_4 = \beta_4^1 \quad \beta_5 = \beta_5^1 \quad \beta_6 = \beta_6^1 \quad \beta_7 = \beta_7^1 \quad \beta_8 = \beta_8^1$$

$$F = \frac{(RSS^R - RSS^U)/(n - n')}{RSS^U/(n'-(k+1))} = \frac{(0.1051 - 0.105)/(74 - 52)}{0.105/43} = 0.0186 \qquad F_{22,74}^{0.01} \approx 1.99$$

With an F-Statistic of 0.0186, we cannot reject the null hypothesis and there is evidence that the model found is applicable to other time periods.

PROBLEMS

1. **PE RATIO**: As data for the PE ratio is unavailable before 1993 we not only have a reduced sample (75 data points) but we also cannot apply the model to stock market crashes. However, a predicted failure test was performed and it was found that the model held over the additional sample. It is also possible, as time goes on to reapply the model should important events happen to the stock market.

2. **MULTICOLLINEARITY:** As mentioned before, it is likely that multicollinearity increased the likelihood of accepting the zero null hypothesis on many variables. However, seeing as the sample size was reduced because of the PE ratio problem, the reduced sample size meant that inclusion of more variables than the eight in the final model was undesirable because it would reduce numerical accuracy.

3. **LAGS OF THE DEPENDENT VARIABLE:** Including lags of the dependent variable implies that shocks to the explanatory variables remain in the model essentially for infinity, rather than just the period that the shock occurs in. This makes prediction in the short run extremely difficult and, in the financial world probably more than any other area, "the long run" is unobtainable.

4. **OMITTED VARIABLES:** Removing linearly related variables might result in omitted variables. One important variables that may have also been omitted is that of investor confidence in the future economy, however this is not really calculable. However as all PC Give tests were past, the omitted variables problem is unlikely.

CONCLUSION

The predictability of monthly returns on the FTSE 100 were investigated by extending the basic random walk model to include macroeconomic variables. The price earnings ratio, consumer spending, retail price index, UK and US interest rates were found to be significant. The aim of the model was to provide investors with a simple, useful, reliable method to predicting returns on the FTSE 100 as a market portfolio. However, there are a number of problems that must be considered.

Firstly, although the model is reliable, with a high R^2, the presence of the lagged dependent variable makes its interpretation much more complex. Secondly, if investors use the information in order to buy / sell positions within the FTSE or place options to reduce downside risk, they must take into account transactions costs. The presence of transaction costs may entirely wipe out any excess returns that could be made by the investors. Thirdly we must consider the suitability of the FTSE 100 as the market portfolio. Technically, the market portfolio consists of all assets world-wide, this includes labour and other non-marketable assets so the true market portfolio is realistically unobtainable. If the true portfolio is unobtainable, perhaps the MSCI world or FTSE All Share may be more suitable? However, if you look at the mutual funds to investors, they are often country specific, which rules out the MSCI World and will often hold a large proportion of their shares in the top companies in the country. I therefore chose to model the FTSE 100 because it is probably the most relevant share index to UK investors.

APPENDIX

Fig 1

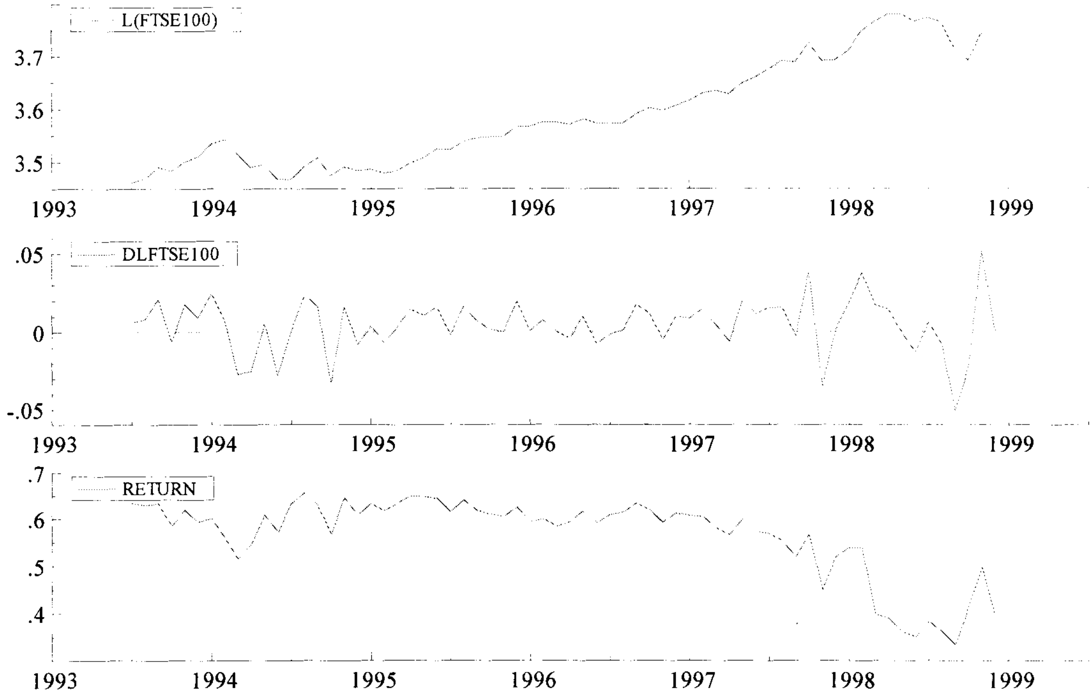


Fig 2

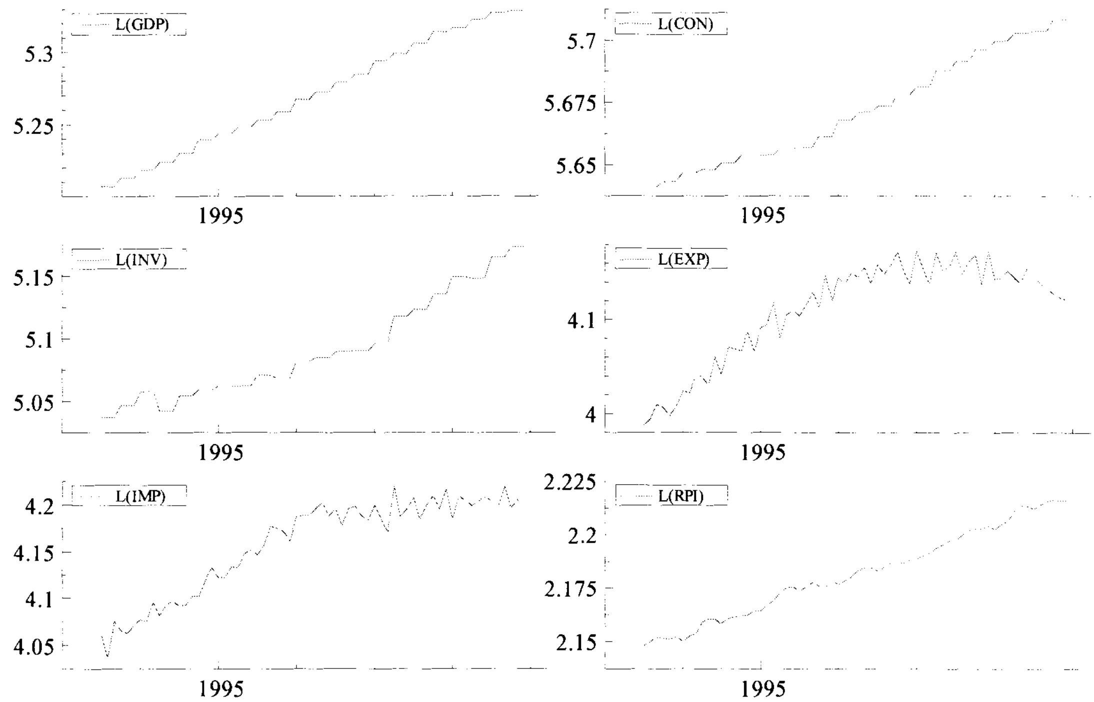
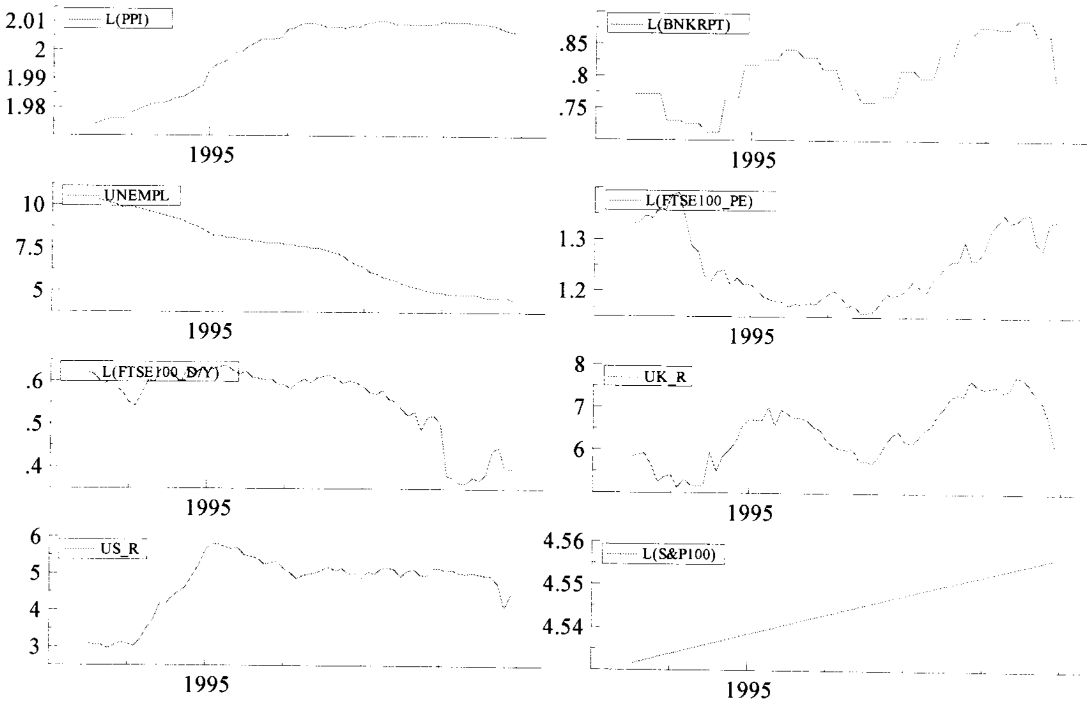


Fig 3



L(PPI)
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L(S&P100)
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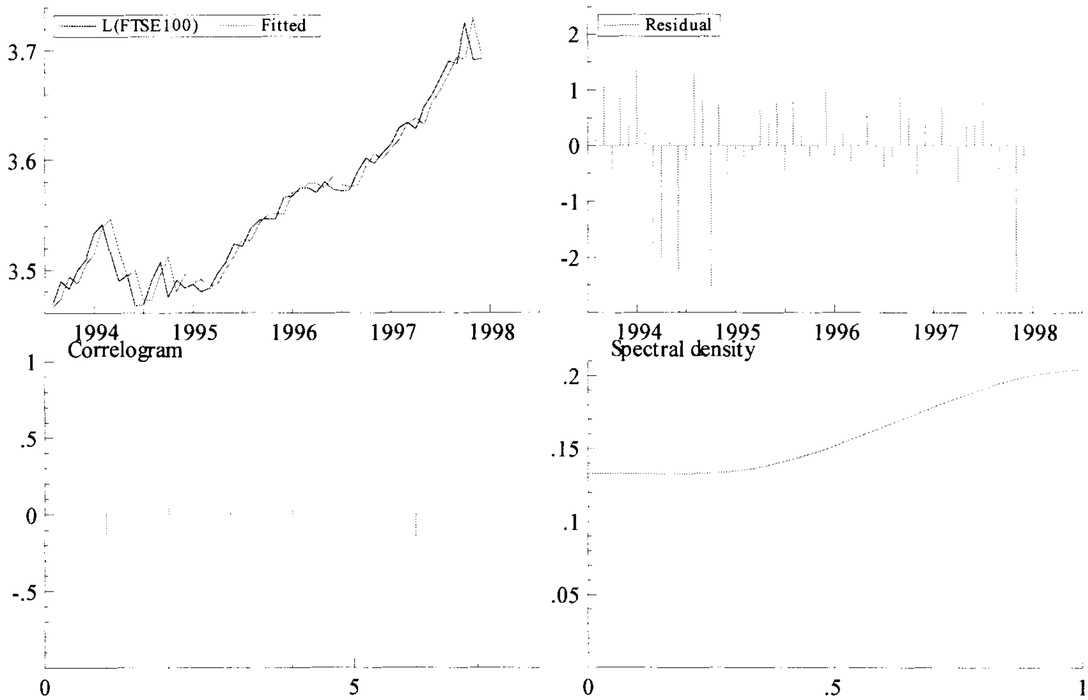
RANDOM WALK

EQ(1) Modelling L(FTSE100) by OLS (using ECAP Data 1.xls)
The present sample is: 1993 (10) to 1997 (12)

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	-0.0098580	0.10920	-0.090	0.9284	0.0002
L(FTSE100)_1	1.0039	0.030688	32.713	0.0000	0.9562

R^2 = 0.956215 F(1,49) = 1070.1 [0.0000] \sigma = 0.0148419 DW = 2.25
RSS = 0.01079387476 for 2 variables and 51 observations

AR 1- 4 F(4, 45)	0.23092 [0.9196]
ARCH 4 F(4, 41)	0.62603 [0.6466]
Normality Chi^2(2)	5.4871 [0.0643]
Xi^2 F(2, 46)	4.3989 [0.0179] *
Xi*Xj F(2, 46)	4.3989 [0.0179] *
RESET F(1, 48)	0.20349 [0.6540]

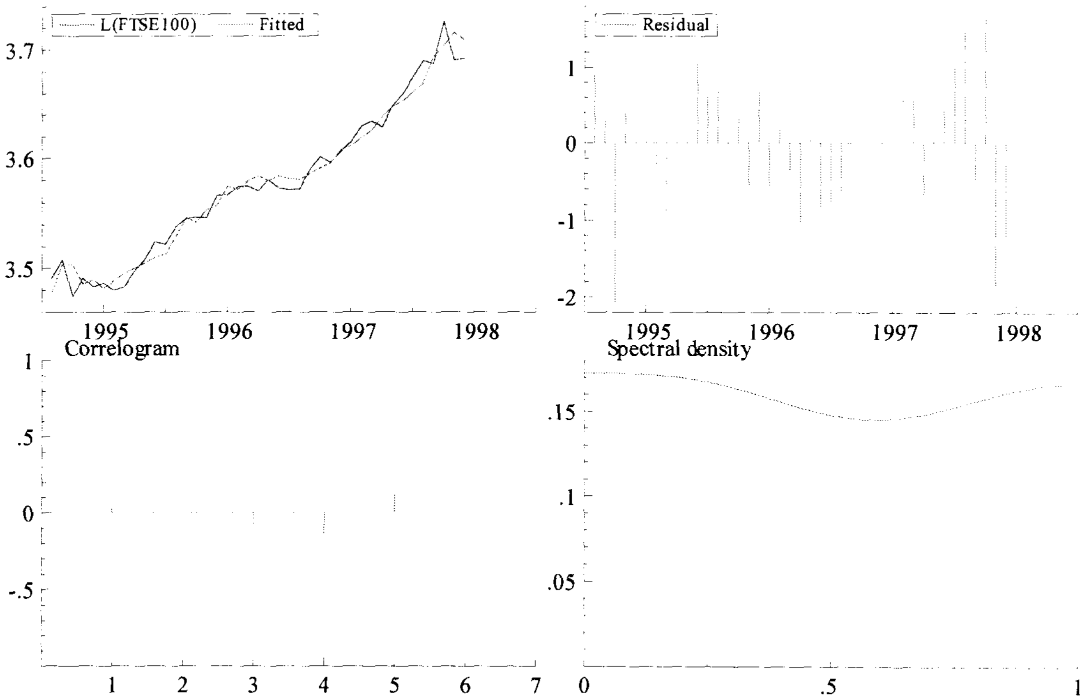


WALD TEST

EQ(2) Modelling L(FTSE100) by OLS (using ECAP Data 1.xls)
The present sample is: 1994 (9) to 1997 (12)

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	-0.028199	0.21605	-0.131	0.8972	0.0007
L(FTSE100)_1	1.0092	0.060417	16.705	0.0000	0.9148
Residuals_1	-0.39309	0.21567	-1.823	0.0799	0.1133
Residuals_2	0.028450	0.25871	0.110	0.9133	0.0005
Residuals_3	0.088798	0.22501	0.395	0.6963	0.0060
Residuals_4	0.24638	0.22728	1.084	0.2883	0.0432
Residuals_5	0.034477	0.20930	0.165	0.8704	0.0010
Residuals_6	-0.28402	0.20325	-1.397	0.1741	0.0699
Residuals_7	0.079839	0.19480	0.410	0.6853	0.0064
Residuals_8	0.13291	0.17972	0.740	0.4662	0.0206
Residuals_9	0.12559	0.18094	0.694	0.4938	0.0182
Residuals_10	0.015515	0.18083	0.086	0.9323	0.0003
Residuals_11	-0.36815	0.18349	-2.006	0.0553	0.1341
Residuals_12	-0.046200	0.17681	-0.261	0.7959	0.0026

R^2 = 0.97554 F(13,26) = 79.766 [0.0000] \sigma = 0.0132435 DW = 2.01
RSS = 0.004560170739 for 14 variables and 40 observations



MODEL 1

EQ(3) Modelling DLFTSE100 by OLS (using ECAP Data 1.xls)
The present sample is: 1993 (10) to 1997 (12)

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	-17.324	20.716	-0.836	0.4500	0.1488
DL(GDP)_1	0.20381	1.1710	0.174	0.8703	0.0075
DL(GDP)_2	0.27371	1.4583	0.188	0.8603	0.0087
DL(GDP)_3	0.026575	1.2296	0.022	0.9838	0.0001
DL(CON)_1	0.83493	1.5277	0.547	0.6138	0.0695
DL(CON)_2	1.8165	1.7807	1.020	0.3653	0.2065
DL(CON)_3	0.16107	1.6526	0.097	0.9270	0.0024
DL(INV)_1	-0.17794	0.38906	-0.457	0.6711	0.0497
DL(INV)_2	-0.10963	0.28430	-0.386	0.7194	0.0358
DL(INV)_3	0.23857	0.24711	0.965	0.3890	0.1890
DL(EXP)_1	0.025044	0.14950	0.168	0.8751	0.0070
DL(EXP)_2	0.16827	0.19032	0.884	0.4266	0.1635
DL(EXP)_3	0.18367	0.17713	1.037	0.3583	0.2119
DL(IMP)_1	0.22200	0.27069	0.820	0.4582	0.1439
DL(IMP)_2	0.18912	0.28276	0.669	0.5402	0.1006
DL(IMP)_3	0.081166	0.16572	0.490	0.6499	0.0566
DL(RPI)_1	-2.6215	2.2543	-1.163	0.3095	0.2527
DL(RPI)_2	-2.5904	1.8649	-1.389	0.2372	0.3254
DL(RPI)_3	-0.36003	1.5021	-0.240	0.8224	0.0142
DL(PPI)_1	-2.2444	2.9329	-0.765	0.4868	0.1277
DL(PPI)_2	2.7063	2.4494	1.105	0.3312	0.2338
DL(PPI)_3	-0.97417	2.5347	-0.384	0.7203	0.0356
L(BNKRPT)_1	-0.13534	0.16704	-0.810	0.4633	0.1410
L(BNKRPT)_2	0.14599	0.13591	1.074	0.3433	0.2239
L(BNKRPT)_3	-0.096080	0.14618	-0.657	0.5469	0.0975
UNEMPL_1	0.029507	0.029716	0.993	0.3769	0.1977
UNEMPL_2	-0.021910	0.033219	-0.660	0.5456	0.0981
UNEMPL_3	-0.0010318	0.027512	-0.038	0.9719	0.0004
UK_R_1	-0.010434	0.011230	-0.929	0.4054	0.1775
UK_R_2	-0.0062212	0.0093630	-0.664	0.5428	0.0994
UK_R_3	0.0095923	0.018167	0.528	0.6254	0.0652
US_R_1	0.0060327	0.015779	0.382	0.7217	0.0353
US_R_2	0.027645	0.027526	1.004	0.3720	0.2014
US_R_3	-0.0042582	0.015901	-0.268	0.8021	0.0176
L(S&P100)_1	-398.27	245.35	-1.623	0.1799	0.3971
L(S&P100)_2	120.39	194.69	0.618	0.5698	0.0872
L(S&P100)_3	281.54	287.89	0.978	0.3835	0.1930
L(FTSE100_PE)_1	-0.063189	0.26504	-0.238	0.8233	0.0140
L(FTSE100_PE)_2	0.17659	0.39568	0.446	0.6785	0.0474
L(FTSE100_PE)_3	0.37660	0.31775	1.185	0.3015	0.2599
L(FTSE100_D/Y)	-1.0758	0.16654	-6.460	0.0030	0.9125
L(FTSE100_D/Y)_1	1.0789	00.27991	3.854	0.0182	0.7879
L(FTSE100_D/Y)_2	0.20920	0.42071	0.497	0.6451	0.0582
L(FTSE100_D/Y)_3	0.23661	0.31803	0.744	0.4982	0.1216

R^2 = 0.987761 F(46,4) = 7.0177 [0.0346] \sigma = 0.00574791 DW = 2.80
RSS = 0.0001321537028 for 47 variables and 51 observations

MODEL 2

EQ(4) Modelling RETURN by OLS (using ECAP Data 1.xls)
The present sample is: 1993 (11) to 1998 (12)

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	-0.62716	35.232	-0.018	0.9860	0.0000
DL(GDP)_1	3.2098	1.8742	1.713	0.1031	0.1337
DL(GDP)_2	-1.8133	2.4673	-0.735	0.4714	0.0276
DL(GDP)_3	3.0534	2.3009	1.327	0.2002	0.0848
DL(CON)_1	-1.3644	2.1190	-0.644	0.5273	0.0214
DL(CON)_2	-1.5209	3.1780	-0.479	0.6377	0.0119
DL(CON)_3	0.74723	2.7592	0.271	0.7895	0.0038
DL(INV)_1	0.24240	0.52771	0.459	0.6512	0.0110
DL(INV)_2	-0.19957	0.47704	-0.418	0.6804	0.0091
DL(INV)_3	0.0063848	0.39233	0.016	0.9872	0.0000
DL(EXP)_1	0.47790	0.25205	1.896	0.0733	0.1591
DL(EXP)_2	0.16831	0.31319	0.537	0.5972	0.0150
DL(EXP)_3	0.18271	0.25268	0.723	0.4784	0.0268
DL(IMP)_1	0.014856	0.35427	0.042	0.9670	0.0001
DL(IMP)_2	0.48247	0.44192	1.092	0.2886	0.0590
DL(IMP)_3	0.32354	0.28197	1.147	0.2655	0.0648
DL(RPI)_1	1.2706	2.4635	0.516	0.6120	0.0138
DL(RPI)_2	-0.71325	2.2893	-0.312	0.7588	0.0051
DL(RPI)_3	0.083799	2.4920	0.034	0.9735	0.0001
DL(PPI)_1	-5.7806	4.6579	-1.241	0.2297	0.0750
DL(PPI)_2	-3.2482	3.6150	-0.899	0.3801	0.0408
DL(PPI)_3	-5.3583	3.8384	-1.396	0.1788	0.0930
L(BNKRPT)_1	0.17550	0.24021	0.731	0.4739	0.0273
L(BNKRPT)_2	-0.23693	0.22589	-1.049	0.3074	0.0547
L(BNKRPT)_3	0.19268	0.17314	1.113	0.2796	0.0612
UNEMPL_1	-0.040883	0.039924	-1.024	0.3187	0.0523
UNEMPL_2	-0.0044914	0.055251	-0.081	0.9361	0.0003
UNEMPL_3	0.054849	0.039347	1.394	0.1794	0.0928
L(FTSE100_PE)_1	-0.91215	0.14962	-6.096	0.0000	0.6617
L(FTSE100_PE)_2	0.78225	0.24359	3.211	0.0046	0.3518
L(FTSE100_PE)_3	0.18057	0.30475	0.592	0.5605	0.0181
UK_R_1	-0.0059809	0.018481	-0.324	0.7498	0.0055
UK_R_2	-0.00064216	0.015331	-0.042	0.9670	0.0001
UK_R_3	-0.011359	0.022330	-0.509	0.6168	0.0134
US_R_1	-0.029354	0.023237	-1.263	0.2218	0.0775
US_R_2	0.034688	0.043486	0.798	0.4349	0.0324
US_R_3	0.020170	0.026846	0.751	0.4617	0.0289
L(S&P100)_1	105.81	416.91	0.254	0.8024	0.0034
L(S&P100)_2	100.56	322.49	0.312	0.7586	0.0051
L(S&P100)_3	-206.29	441.27	-0.467	0.6455	0.0114
RETURN_1	0.72412	0.20421	3.546	0.0022	0.3982
RETURN_2	-0.033056	0.24579	-0.134	0.8944	0.0010
RETURN_3	0.12290	0.12752	0.964	0.3473	0.0466

R^2 = 0.993256 F(42,19) = 66.626 [0.0000] \sigma = 0.0124888 DW = 2.05
RSS = 0.002963437042 for 43 variables and 62 observations

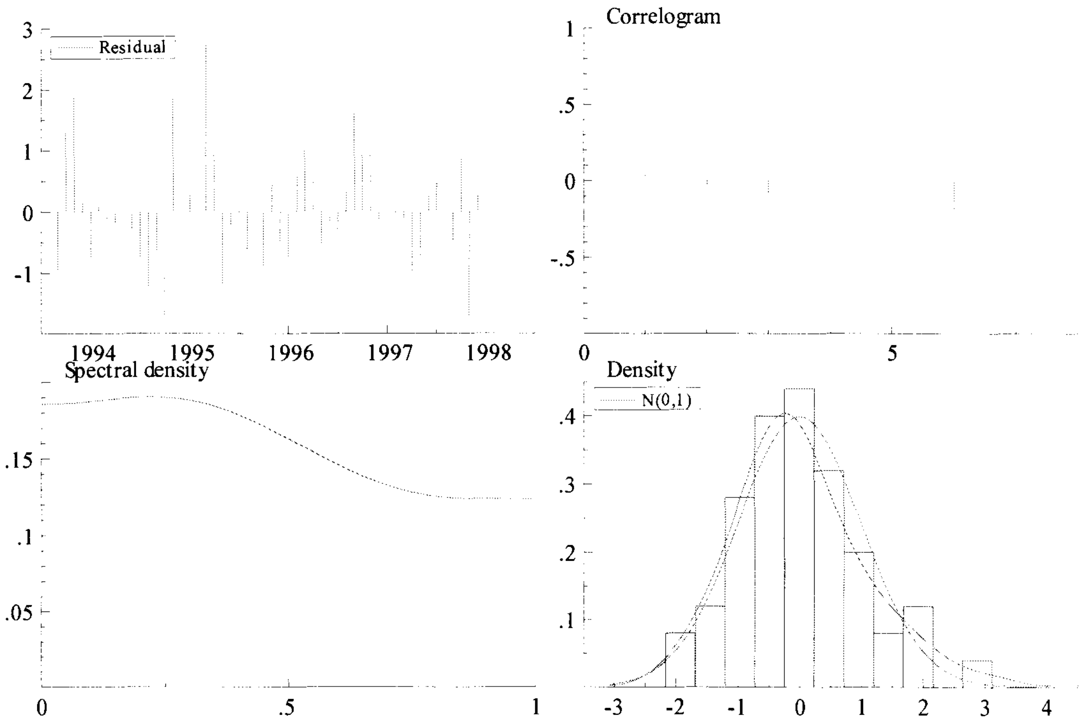
FINAL MODEL

EQ(5) Modelling RETURN by OLS (using ECAP DATA 2.xls)
The present sample is: 1993 (9) to 1997 (12)

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	0.020166	0.025401	0.794	0.4316	0.0144
RETURN_1	0.95574	0.032063	29.808	0.0000	0.9538
DLFTSE_100_PE_1	-0.82309	0.051299	-16.045	0.0000	0.8569
DLRPI_1	-2.0149	0.57268	-3.518	0.0010	0.2235
DLRPI_2	-0.96281	0.57264	-1.681	0.0999	0.0617
DCON1_1	0.54552	0.53102	1.027	0.3100	0.0240
DCON1_2	1.7620	0.50435	3.494	0.0011	0.2211
UK_R_1	-0.0018268	0.0024303	-0.752	0.4563	0.0130
US_R_1	0.0030838	0.0015259	2.021	0.0495	0.0867

R^2 = 0.975392 F(8,43) = 213.05 [0.0000] \sigma = 0.00592165 DW = 1.70
RSS = 0.001507834525 for 9 variables and 52 observations

AR 1- 4 F(4, 39)	0.27397 [0.8930]
ARCH 4 F(4, 35)	0.94418 [0.4501]
Normality Chi^2(2)	3.8586 [0.1453]
Xi^2 F(16, 26)	0.7133 [0.7566]
RESET F(1, 42)	3.4738 [0.0693]



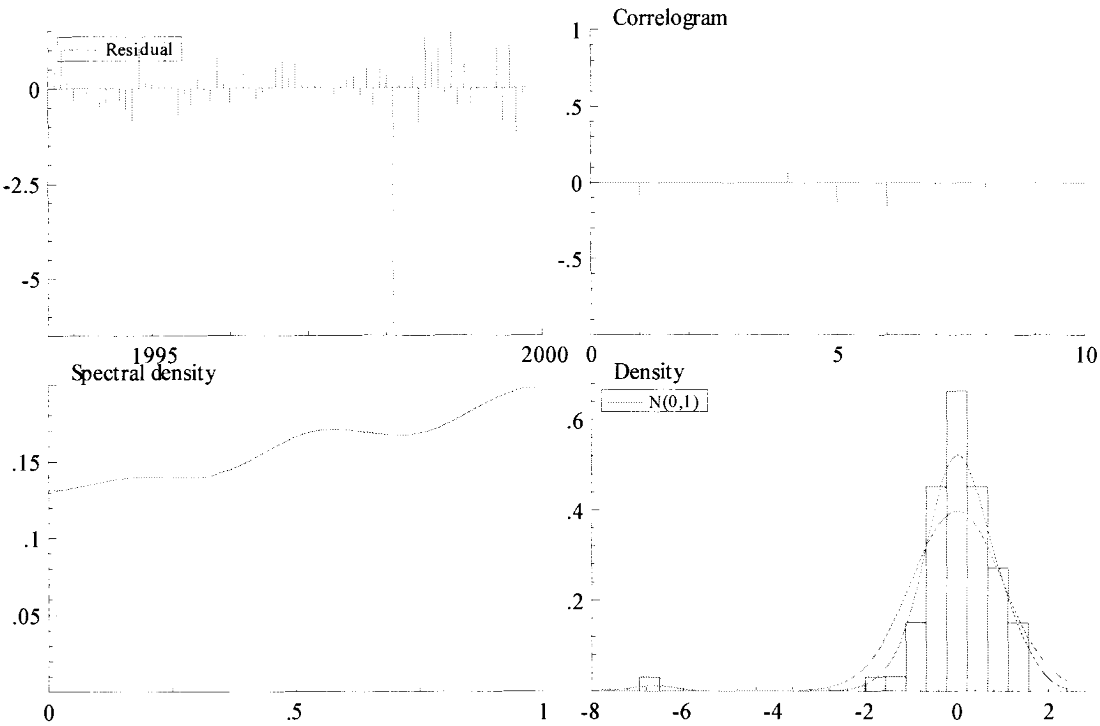
PREDICTED FAILURE TEST

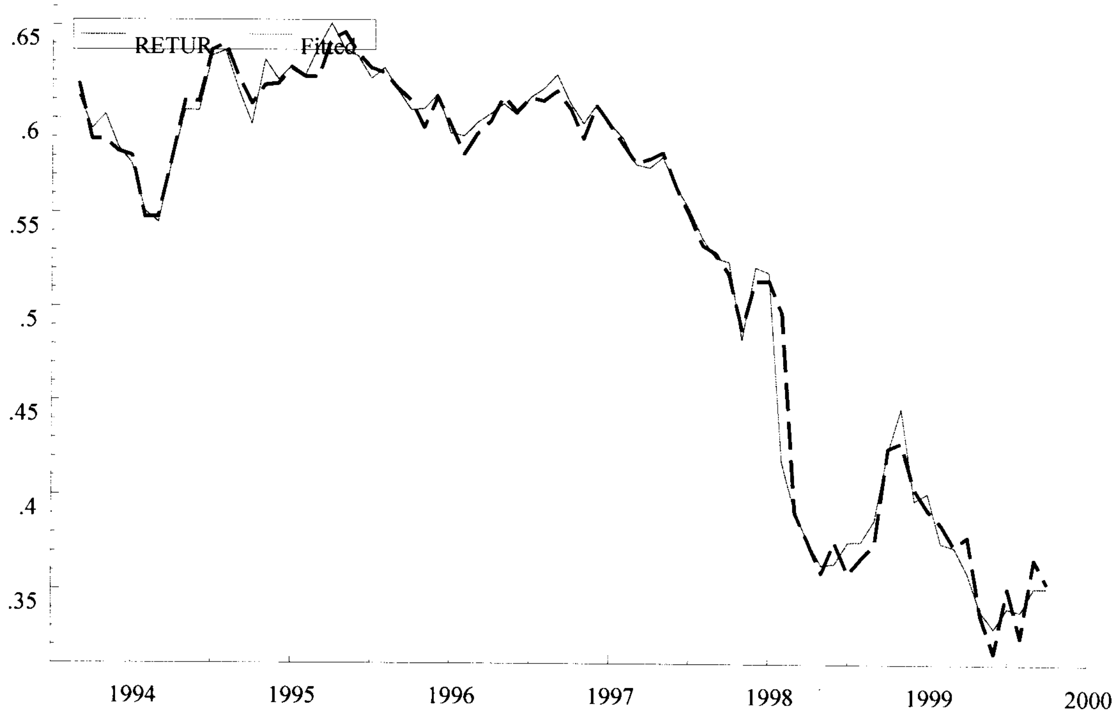
EQ(7) Modelling RETURN by OLS (using ECAP DATA 2.xls)
The present sample is: 1993 (9) to 1999 (10)

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	0.026983	0.016474	1.638	0.1063	0.0396
RETURN_1	0.96453	0.015288	63.092	0.0000	0.9839
DLFTSE_100_PE_1	-0.79243	0.078094	-10.147	0.0000	0.6130
DLRPI_1	-0.70752	1.0098	-0.701	0.4860	0.0075
DLRPI_2	-0.64051	1.0054	-0.637	0.5263	0.0062
DCON1_1	0.21592	0.93025	0.232	0.8172	0.0008
DCON1_2	1.8353	0.89554	2.049	0.0445	0.0607
UK_R_1	-0.0039591	0.0023432	-1.690	0.0959	0.0421
US_R_1	0.0028110	0.0023209	1.211	0.2302	0.0221

R^2 = 0.986956 F(8,65) = 614.78 [0.0000] \sigma = 0.0127123 DW = 2.18
RSS = 0.01050424063 for 9 variables and 74 observations

AR 1- 4 F(4, 61)	0.22846 [0.9214]
ARCH 4 F(4, 57)	0.027083 [0.9985]
Normality Chi^2(2)	109.45 [0.0000] **
Xi^2 F(16, 48)	1.0184 [0.4551]
Xi*Xj F(43, 21)	0.51949 [0.9656]
RESET F(1, 64)	3.1978 [0.0785]

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