The University of Reading Business School
Department of Real Estate & Planning

Working Papers in Real Estate & Planning 01/06

The University of Reading

The Inflation Hedging Characteristics of US and UK Investments: A Multi-Factor Error Correction Approach

Martin Hoesli*, Colin Lizieri**, Bryan MacGregor***

Last update: 06 January 2006
Please contact authors for latest version

A version of this paper was presented at the American Real Estate and Urban Economics Association's Annual Meeting in Boston in January 2006.

* University of Geneva, HEC, 40 boulevard du Pont-d'Arve, CH-1211 Geneva 4, Switzerland and University of Aberdeen Business School, Dunbar Street, Aberdeen, AB24 3FX; Scotland, UK, email: martin.hoesli@hec.unige.ch

** University of Reading Business School, Whiteknights, Reading, RG66AW, UK, email: c.m.lizieri@rdg.ac.uk, phone: +44 (0)118 378 6339 (contact author)

*** University of Aberdeen Business School, Dunbar Street, Aberdeen, AB24 3FX; Scotland, UK, email: b.d.macgregor@abdn.ac.uk

The Inflation Hedging Characteristics of US and UK Investments: a Multi-Factor Error Correction Approach

Abstract

Historic analysis of the inflation hedging properties of stocks produced anomalous results, with equities often appearing to offer a perverse hedge against inflation. This has been attributed to the impact of real and monetary shocks to the economy, which influence both inflation and asset returns. It has been argued that real estate should provide a better hedge: however, empirical results have been mixed. This paper explores the relationship between commercial real estate returns (from both private and public markets) and economic, fiscal and monetary factors and inflation for US and UK markets. Comparative analysis of general equity and small capitalisation stock returns in both markets is carried out. Inflation is subdivided into expected and unexpected components using different estimation techniques. The analyses are undertaken using long-run error correction techniques. In the long-run, once real and monetary variables are included, asset returns are positively linked to anticipated inflation but not to inflation shocks. Adjustment processes are, however, gradual and not within period. Real estate returns, particularly direct market returns, exhibit characteristics that differ from equities.

Keywords: *Investment Returns, Real Estate, Inflation Hedging, Error Correction Model*

1. Introduction

In considering the role of real estate in mixed-asset portfolios, many industry commentators point to its supposed inflation hedging qualities. Were this to be the case, this would be a highly desirable characteristic, particularly for those institutional investors such as pension funds who need to match real liabilities. Given the apparent anomaly that equities do not exhibit the expected inflation hedging characteristics and, indeed, may act as a perverse hedge, evidence of a positive relationship between property and inflation would encourage higher allocations to the asset class. In practice, however, research on the relationship between inflation and real estate returns provides variable results. While there is some evidence that directly-owned private real estate provides a partial hedge against some components of inflation (e.g., Gyourko & Linneman, 1988), securitised real estate is often shown to exhibit the same negative relationships found in stock market research – particularly with respect to unexpected inflation (Liu *et al*., 1997).

A number of explanations for the observed negative relationship between inflation and stock returns have been advanced. Following Fama (1981), it has been suggested that the observed inflation-stock relationships are spurious as a result of missing variables – notably real activity, price uncertainty and monetary shocks. Distinctions are further made between short-run and long-run relationships with the hypothesis that longer time horizons will result in a positive relationship in accordance with the expected Fisher relationship (Boudoukh & Richardson, 1993). Equilibrium models suggest that the relationship between price changes and equity returns depends on the source of the change in inflation (monetary or real). Some of these models have also been applied to real estate returns, with mixed results however. Research into real estate returns is made problematic by measurement problems. The thinly traded private market leads to a reliance on appraisal-based returns which may not fully reflect market pricing movements; in the public market, returns reflect not only the underlying asset base but also the capital structure and a general tendency to track overall equity indices. Also, very long historical series for directly-owned real estate are not available.

This paper explores the relationship between commercial real estate returns (from both private and public markets), economic factors and inflation for US and UK markets. Comparative analysis of general equity market and small capitalisation stock returns is performed. Inflation is subdivided into expected and unexpected components using a variety of different estimation techniques for the anticipated component of inflation. The properties of each estimate are compared to a set of ideal attributes. These point to the use of a moving average process for inflation, although other formulations are tested.

The main contribution of the paper is to use an ECM framework to model the long-run and short-run relationships between asset returns and the components of inflation. Moreover, we consider the spurious relationship hypothesis of Fama (1981) by including real and monetary variables in our models. A variant of this approach has been used previously (Glascock *et al.*, 2002), but for US REITs only, and with less than conclusive results. We consider stocks, small cap stocks, real estate securities and direct real estate in the US and UK. This approach appears well suited as it links the proxy hypothesis framework with a long run framework of the linkages between inflation, real activity, money variables and asset returns.

Our results show that in the long-run, once real activity and monetary changes are included, asset returns are positively linked to anticipated inflation, but not to inflation shocks. However, adjustment processes are gradual and occur through the error correction adjustment process and not through direct, in-period changes to inflation. The behaviour of real estate asset returns differs from equity and small cap stock returns, but the differences are most marked for private markets which may point to a data composition effect. There are differences between the US and UK results, with world output and world equity returns having a significant impact on returns in the smaller and more externally oriented market.

The next section reviews evidence that stock returns act as a perverse hedge against inflation and the explanations provided for that apparent anomaly. The literature on the relationship between real estate and inflation is then explored (section 3). The fourth and fifth sections set out the methods used and the data employed to analyse inflation-return relationships, respectively. Finally results are set out and conclusions drawn.

2. Stocks as a Perverse Hedge and the Proxy Hypothesis

The theory of interest rates, derived from the work of Fisher (1930), suggests that, in expectations, the nominal return should equal the real return plus anticipated inflation. From this, one would expect that asset returns would hedge against expected inflation. However, from the 1970s, empirical evidence from equity markets failed to confirm this expectation – indeed stocks appeared to be a perverse hedge against inflation in most countries (for example, Lintner, 1975; Bodie, 1976; Jaffe & Mandelker, 1976; Nelson, 1976; Fama & Schwert, 1977), but not in the UK (Firth, 1979). A body of literature has developed that has attempted to explain the anomaly. Generally, it is argued that observed negative relationships are spurious and caused by missing variables in explanatory models – that is, (expected) inflation is a proxy for other variables.

The 'proxy hypothesis' can be traced to Fama (1981), who argues that the observed negative correlation results from a link between inflation and the level of real activity. His hypothesis is based on money-demand theory and the quantity theory of money. The quantity theory of money holds that (with the rate of return and real activity constant), the demand for real money is unaffected by changes in nominal money – and that changes in nominal money must thus be accommodated by changes in the level of prices. By contrast, an increase in real activity, holding other variables constant, reduces the price level. Those increases in real activity put pressure on the existing capital stock, raising returns and inducing capital expenditure. To complete the circle, stock returns rise in anticipation of the investment and higher returns. With real activity, *ceteris paribus,* leading to lower prices, this induces the observed, but spurious, negative correlation between stock returns and future inflation. Separating inflation into its expected and unanticipated components, he provides empirical backing from US stock market data. Support for the Fama model is also found in Vanderhoff & Vanderhoff (1986) and Lee (1992). Boudoukh *et al*. (1994) argue that the proxy effect should be stronger in firms in highly cyclical sectors than for those in non-cyclical sectors. They provide empirical confirmation but cannot fully explain cross-sectional differences by the inflation-output relationship.

Geske and Roll (1983) provide an alternative model whose basis is debt monetization by central banks. Money supply should not be influenced by real shocks. However, in downturns, faced with unemployment and falling output (and tax revenues), monetary authorities may operate a counter-cyclical policy. An increase in the (nominal) money supply leads to an increase in inflation; stocks anticipate the change in activity level – hence the observed negative correlation between stocks and inflation results from monetization. Kaul (1987, 1990) provides empirical support for the Fama model and notes that monetary policy can be pro- or counter-cyclical. While including real activity in models renders the influence of inflation insignificant, changes in expected inflation are negatively related to stock returns.

Kaul and Seyhun (1990) develop this last idea by arguing that relative price variability has a detrimental effect on output and employment, as a result of a reduction in the information content of prices and the need to put in place more costly institutional arrangements to control for price uncertainty. Relative price variability is defined as cross-sectional variability in price changes for components of the producer price index. Relative price variability is positively correlated with inflation (particularly unexpected inflation). In regressions of stock returns that include change in future industrial production on the right hand side, contemporaneous relative price variability is significantly and negatively linked to equity market performance, and both expected and unexpected inflation are insignificant. However, relative price variability itself appears to be strongly associated with real supply shocks (notably the oil price shocks of the seventies).

A third strand in the debate comes from the development of general equilibrium models by, for example, Danthine & Donaldson (1986), Stulz (1986), Lee (1989), Marshall (1992) and Bakshi & Chen (1996). These suggest that stocks may fail to offer a hedge against inflation when the source of that inflation is non-monetary but arises from real output shocks. Depending on the assumptions made, negative or positive cross-correlations may result. The empirical and simulation evidence from such models is similarly mixed.

Much of the early work testing the proxy hypothesis (in both its output and monetary policy versions) relied on standard regression-based models and relatively high frequency data. There is some suggestion in the literature that when longer time increments are considered, the Fisher model performs better (e.g. Boudoukh & Richardson, 1993, Solnik & Solnik, 1997). Subsequent research has tended to focus on long-run relationships, co-integration and responses to shocks. Cochran and Defina (1993) use an error correction mechanism (ECM) approach. They argue that using future (period ahead) actual output as a measure of expected output ignores uncertainty. They add a measure of inflation uncertainty (which is correlated with inflation), with oil prices used to capture relative price impacts. With real activity variables (and forecasts of future activity) included both inflation and inflation uncertainty still have a negative impact, although the former's impact is transitory. Balduzzi (1995) finds strong dynamic interaction between inflation and stocks and attributes much of the negative relationship to changes in interest rates.

Hess & Lee (1999) argue that stock returns relate to inflation through two sorts of shocks: supply disturbances (real output shocks) give negative stock-inflation relations while demand disturbances (monetary shocks) drive positive relationships. They focus on responses to shocks in a system that includes inflation, monetary base, industrial production and equity prices. Consistent with equilibrium models, supply shocks have an initial positive impact on stocks (which dissipates) and a negative and persistent effect on inflation, driving a negative relationship between inflation and stocks. Demand shocks have initially positive impacts on both stocks and inflation, generating a positive correlation. While the reported results focus on the US, the authors claim the results are paralleled in the UK, Germany and Japan. A prior paper by Ely & Robinson (1997) uses vector error correction models (VECM) to examine the response of stock prices (not returns) to a set of inflation variables and to industrial production, GDP and money supply variables for a range of developed countries. The results are inconclusive. For US markets they claim, in contrast to most other studies, that real output shocks have negative impacts on stock prices, while monetary shocks have, at best, weakly positive impacts. Few significant relationships are found for the other countries in their sample although, in general, stocks maintain their long-run value relative to goods prices.

Lee (1999) focuses on the dividend component of returns. The model tested hypothesises that the observed negative correlation between returns and unexpected inflation is driven by a time varying uncertainty premium (derived using a conditional variance approach) which, in turn, is driven by time-varying inflation uncertainty. The empirical results suggest that the uncertainty premium dominates unexpected inflation in explaining stock returns, providing some support for the Kaul and Seyhun (1990) approach. In similar vein, Pilotte (2003) divides returns into capital and income components showing that the relationship between expected inflation and returns differs for dividend yields and price appreciation whenever the covariance between real price/dividend ratios and inflation is non-zero.

Chopin and Zhong (2001) use a VECM method to compare the Fama and Geske & Roll models. They argue that both real activity and monetary fluctuations generate contemporaneous correlations between stocks and inflation. However, they suggest that there is no clear evidence either, that the Federal Reserve monetize deficits, nor that Government deficits drive real activity levels. As a result, they provide stronger support for the Fama approach. Their model suggests that shocks come from long-run disequilibrium in the real economy.

The balance of research, then, provides support for Fama's proxy hypothesis. Stock market returns react positively to real output increases. However, equity markets anticipate output changes and, other things equal, positive real output changes result in falling prices. This contributes to the observed perverse inflation hedge results and negative correlation between stock returns and anticipated inflation. The empirical evidence for the monetary policy hypothesis is weaker – partly due to the differing nature of monetary regimes. A third component is uncertainty – both of output and of inflation. Uncertainty and price volatility depresses both output and stock prices. The research reviewed here focuses on equity markets. The next section explores parallel research into the relationship between inflation and commercial real estate returns.

3. Real Estate and Inflation

In researching the inflation hedging qualities of commercial (investment) real estate, a distinction needs to be made between private (unsecuritised) and public (securitised) assets. In both cases, there are conceptual and data-related issues. For private real estate, researchers are forced to rely largely on appraisal-based portfolio indices such as those provided by IPD or NCREIF, or on proxy series based on rental values and capitalisation rates. Appraisal-based indices are influenced by valuer behaviour (for example, an appraiser might adjust a prior value to reflect known inflation) and may be distorted by appraisal smoothing. Securitised real estate returns are based on transactions; however the delivered returns depend, in addition to the performance of the underlying property assets, on the leverage of firms and on management behaviour. This last effect will depend on the structure of the firm, with the high distribution requirements of REIT-like structures providing less flexibility for management influence than, say, UK property company structures.

Underlying real estate returns derive from both income and capital appreciation. Rental income might be expected to be responsive to inflation, in the sense that this will increase the nominal turnover of the tenants occupying the building. If the landlord's share remains constant, then nominal rents will rise accordingly. The transmission effects will depend on lease structures that may build in lags. Retail turnover rents and index-linked rents will be more responsive than those that are fixed for the life of the lease or only reviewed periodically – lease length and rent review period determining the adjustment lags. However, an increase in real output will also increase the demand for space (not least due to the lag in producing new supply in response to a demand shock) and, as discussed above, a real output shock, for a given monetary stance, places downward pressure on prices. Capital value reflects the rental level and the capitalisation rate. The latter can be decomposed into the required return (risk free rate and risk premium) and an anticipated rental growth component, k = RFR + RP – E(g). Given that E(g) reflects inflationary growth and the risk free rate under the Fisher model compensates investors for anticipated inflation, expected inflation would not be expected to have a significant impact on the cap rate. However, where fiscal authorities use interest rate policy to control inflation, a rise in (anticipated or observed) inflation might lead to expectations of rising interest rates and, hence, declining capital values.

The balance of evidence from the private commercial real estate market points to property acting as a partial inflation hedge. For US markets, Hartzell *et al.* (1987) analysed appraisal-based returns from a CREF portfolio with the Fama-Schwert model and find coefficients in excess of one for both expected and unexpected inflation. Gyourko & Linneman (1988) get much more mixed results, but suggest that returns from income-producing properties tend to have a positive relationship with inflation. They suggest that there is an omitted variable bias in the analysis. Wurtzebach *et al.* (1991) find that real estate hedges inflation – except where markets are oversupplied. They use vacancy rate as their measure of real estate market disequilibrium. Other analyses finding evidence of a hedge include Miles & McCue (1982) and Sirmans & Sirmans (1987).

Outside the US, Newell (1996) suggests that Australian direct real estate at least partially hedges both expected and unexpected inflation, although the results are much less clear when vacancy rates are added to the model. Hoesli *et al.* (1997) examine UK real estate, separating out income, rental value and capital appreciation components of returns. They also attempt to correct for appraisal smoothing. They hypothesise that rental value will be a hedge against expected inflation, but because of the rent review process, income return will be at best a weak hedge against expected inflation and offer little protection against inflation shocks. In most cases, the coefficients obtained are significantly less than one, with those relating to unexpected inflation being negatively signed (but not significantly different from zero). Barber *et al.* (1997) utilise a structural time series approach to suggest that UK real estate provides, at best, a weak hedge against changes in underlying inflation but no hedge against shocks that change price levels nor to irregular price fluctuations. Thus only 'core' inflation is hedged and there are large variations with respect to type of return and sector of activity. These UK findings are broadly consistent with earlier work: Limmack & Ward (1988) argue that property sectors hedge expected, but not unexpected, inflation.

The difficulties posed by low frequency data and questions about the reliability of appraisal-based returns have focused attention on the securitised real estate market. Early US REIT studies tend to confirm the findings from common stock market research. Brueggeman *et al.* (1984), Gyourko & Linneman (1988), Goebel & Kim (1989), Murphy & Kleiman (1989), Titman & Warga (1986), Park *et al.* (1990) and Larsen & McQueen (1995) all find coefficients that are negative or non-significant, with REITs often appearing to be a perverse hedge against unexpected inflation. Most of these studies model inflation sensitivity directly in a Fama-Schwert framework, although some include other variables. For example, Murphy & Kleiman (1989) run models that exclude and then include the market index on the right hand side and find observed significant negative coefficients for inflation sensitivity in the former but coefficients that are indistinguishable from zero in the latter. Non-US studies include Hoesli *et al.* (1997), who cannot find evidence that UK property companies hedge components of inflation, and Liu *et al.* (1997) who provide international evidence pointing to zero or negative coefficients.

Darrat & Glascock (1989) explicitly address the proxy hypothesis, modelling monetary policy and financial variables, in particular, movements in federal budget deficits. They argue that budget deficits are linked to increases in uncertainty, equity premia and to bond returns and, hence, to real estate returns. Their property dataset contains a mixture of REITs, building firms and taxable real estate investors. Using causality testing and added-variable regression approaches, they include macro variables including industrial production, unemployment and inflation, along with the market return and risk premia. Monetary base has a lagged negative impact on REIT returns (which would generate an observed negative relationship between real estate returns and inflation), with the budget deficit and monetary base linked through monetization.

Glascock *et al.* (2002) revisit this model using a VECM approach. Starting with a standard Fama-Schwert model they find significant negative coefficients for general and expected inflation and a negative but non-significant coefficient for unexpected inflation. They find evidence of cointegration between REIT returns and the CPI generally and with its expected and unexpected components. Innovations in REIT returns lead to negative changes to both expected and unexpected inflation (which would be consistent with a real output model for a given level of money). They then use the Federal Fund Rate as a proxy for monetary policy and industrial production as a proxy for real output. Including these, the inflation coefficients became non-significant leading them to argue that it is monetary policy that causes the observed negative relationship. Chatrath & Liang (1998) also find a long-run co-integration of EREITs with CPI but the links are weak and method dependent.

Inflation also appears as a variable in a number of factor model studies that use IACM or the macro-factor version of arbitrage pricing theory to investigate the real estate return generating process. Chen & Tzang (1988) use an inter-temporal CAPM to investigate interest rate sensitivity but split interest rates into a real rate and expected inflation. The sign on the latter is significantly negative. Chan *et al.* (1990) find that change in expected inflation is not significant but unexpected inflation is weakly negative in return models using indices of returns. They remodel using a mimicking portfolio approach: unexpected inflation has a significant negative impact but the sign on changes in inflation expectations is positive. Chen *et al.* (1998) examine cross-sectional variation in REIT returns but find that firm-specific size effects dominate macro-factors.

Ling and Naranjo (1997) examine both securitised and private real estate using a multi-factor approach. Key factors driving returns are growth in real per capita consumption, the real Treasury bill rate, term structure and unexpected inflation. Consumption and real interest rates dominate the return generation process. Unexpected inflation is not significant using a constant risk premium approach but becomes significant using a time-varying premium model. Ling and Naranjo (1999) examine differences between factor sensitivities in real estate and general equity markets. Inflation does not appear as a significant factor in either fixed effect or time varying models.

The mixed results reported above reflect the difficulties in measuring real estate performance and the lack of long period, high frequency time series – compounded, given the focus on US REITs, by structural change in the REIT industry in the 1990s. There is some evidence of direct real estate acting as a partial hedge against some components of inflation, while public, securitised real estate seems to exhibit the negative relationships found in equity markets. Results differ across time periods, market conditions, national boundaries and by components of returns and vary depending on what conditioning variables are included in the models. The remainder of this paper attempts to disentangle the relationships between real variables, returns and the components of inflation.

4. Methods

4.1 Inflation Hedging, Anticipated Inflation and Inflation Shocks

In the Fama & Schwert (1977) model, asset returns are tested against measures of expected and unexpected inflation:

$$R_t = \beta_0 + \beta_1 E(I)_{t-1} + \gamma_1 UI_t + \upsilon_t \quad (1)$$

where $E(I)_{t-1}$, is the anticipated inflation up to time period t, conditional on information at time t-1. This requires an estimate of the expected inflation rate to time t, which is not directly observable[1]. A variety of methods have been used to find a proxy for the anticipated component.

Many of the "traditional" inflation hedging papers use a method based on Fisher interest rate theorem, generally attributed to Fama & Gibbons (1984)[2]. The starting point is the assumption that the risk free rate (proxied by the expected return on a Treasury bill) is the sum of the expected real rate and the expected rate of price inflation:

$TB_{t-1} = E(R)_{t-1} + E(I)_{t-1}$ and hence, by rearrangement:

$$E(I)_{t-1} = TB_{t-1} - E(R)_{t-1}. \quad (2)$$

[1] In principle, the expected inflation rate is observable in the UK due to the presence of index-linked government bonds which are bought and sold in the secondary market: in practice, there is an additional inflation risk in the yield to redemption of the index-linked bond, since the indexation point precedes the redemption date; also it is unlikely that there will be bonds maturing at the precise date of each analysis period.

[2] Papers using the Fama & Gibbons framework include Chen & Tzang (1988), Geske & Roll (1983), Glascock *et al.* (2002), Kaul (1987) and Murphy & Kleinman (1989).

Some early work assumes a constant real rate of return, but most models allow for a time varying real rate either in terms of a varying constant:

$$I_t = \alpha_{t-1} + \beta_1 TB_{t-1} + \eta_t \quad (3)$$

or by taking a weighted average of past real rates (estimated as the prior Treasury Bill rate less the actual inflation):

$$EI_t = TB_{t-1} - \frac{1}{k}\sum_{s=t-1}^{t-k}(TB_{s-1} - I_s)\,. \quad (4)$$

An alternative procedure would be to assume some sort of adaptive expectations approach, where the next inflation estimate is based on the prior anticipated inflation rate, adjusted for the difference between actual inflation this period and the prior expectation.

$$E(I)_t = E(I)_{t-1} + \gamma[I_t - E(I)_{t-1}] \quad (5)$$

This then lends itself to a univariate time series approach using Box-Jenkins / ARIMA approaches – the second most common form of approach in the inflation hedging literature[3]:

$$E(I)_t = \beta_0 + \sum_{k=1}^{k}\beta_i I_{t-k} + \eta_t \quad (6)$$

Here, the fitted value for $E(I)_t$ is taken as the anticipated inflation and the residual η_t is the unexpected inflation. There is no consistency in the lag lengths employed. Other methods encountered include the use of the Hoddrick-Prescott filter and the assumption that the previous period's inflation is the best estimate of the next period's (effectively assuming a random walk).

In Fama's (1981) proxy hypothesis paper, inflation is explained in terms of the growth of the monetary base (BG_t) and the real growth rate of industrial production (δPR_t), both contemporaneous and in the future (implicitly assuming perfect foresight):

$$I_t = \beta_0 + \beta_1 BG_t + \beta_2 \delta PR_t + \beta_3 \delta PR_{t+k} + \eta_t\,. \quad (7)$$

This approach has analogies with multi-factor return and arbitrate pricing theory models. Borrowing from Ling & Naranjo (1997), the return on asset i at time t is given by:

[3] For example, Chatrath & Liang (1998), Cochran & Defina (1993), Gyourko & Linneman (1988) and Kaul & Seyhun (1990).

$$R_{it} = \lambda_0 + \sum_{k=1}^{k} \beta_{ikt} \lambda_{kt} + \sum_{k=1}^{k} \beta_{ikt} [\overline{F}_{kt} - E(F)_{kt}] + \varepsilon_{it} \quad (8)$$

where λ_0 is the zero beta excess return, β_{ikt} is the time sensitivity to factor k, λ_{kt} is the risk premium for factor k and the term $[\overline{F}_{kt} - E(F)_{kt}]$ is the shock or innovation for factor k at time t. This requires an estimate for shocks in the real factors (in particular where these are macro factors and not derived from exploratory statistical analyses and mimicking portfolios). The majority of such studies use univariate Box-Jenkins / ARIMA approaches to estimate expectations for the factors, with innovations defined as the residual of the estimation equation. These methods, however, rely on accurate period by period measurement and transmission mechanisms. The development of dynamic, long-run time series approaches in econometrics points towards a different approach to examining the interrelationships. In this paper, error correction models will be used to examine long run integration and dynamic adjustments between asset returns, real variables and inflation.

4.2 Error Correction Models

The fundamental idea in an Error Correction Model (ECM) is of a stable long-run relationship among variables that change over time. This relationship provides the time-varying equilibrium to which the system tends. An ECM comprises this long-run relationship and a short-run equation that describes how the long-run solution is achieved through negative feedback and error correction (Harvey, 1990; Darnell, 1994).

The long-run relationship is specified in levels, and the short-run adjustment in first differences.

In this paper, the long-run or equilibrium relationship is:

$$R_t^* = \beta_0 + \sum_{i=1}^{n} \beta_i X_{it} \quad (9)$$

where R_t^* is the level of the nominal returns index and X_{it} are explanatory variables, including expected and unexpected inflation, at time *t*. The residual of this equation is:

$$u_t = R_t - \hat{\beta}_0 - \sum_{i=1}^{n} \hat{\beta}_i X_{it} \qquad (10)$$

where R_t is the fitted value. If the left hand side and right hand side variables are co-integrated, the error is stationary and can be used in the short-run model as an EC term. Short-term changes in the index of returns are driven by changes in the explanatory variables in the long run relationship and by adjustments to previous disequilibrium in the long-run relationship.

$$r_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i x_{it} - \gamma u_{t-1} \qquad (11)$$

where lower case is used to denote first differences of the variables in the long-run model. Thus, the nominal returns are driven by short-run changes in the causal variables and also by the lagged disequilibrium. The degree of adjustment is indicated by the coefficient, γ: $\gamma = 1$ means full adjustment, $0 < \gamma < 1$ means partial adjustment and $\gamma = 0$ means no adjustment. It is also possible to include multiple lags of the explanatory variables and of the dependent variables.

5. Data and Preliminary Tests

5.1 Data

A dataset was assembled for US and UK markets that included variables used in prior studies or suggested in theoretical expositions. The series length and frequency was largely determined by the availability of real estate and macro-economic data. Appendix A contains full descriptions of the variables and provides sources. The time series variables used in the analysis ran from 1977 to end 2003 and were available quarterly. Most of the financial series were obtained from DataStream, while macro data were extracted from online Government databases.

For the US, the asset market indices were DataStream's total equity market index[4]; the Standard & Poors 600 small cap stock index; the NAREIT (all types) series and the NCREIF "classic" series. Total returns and capital appreciation series were available, with an implied income series estimated from these. Macro-economic data series included in the analysis were US GDP (seasonally adjusted); US industrial production; House Price appreciation; an Oil Price series; the Consumer Price Index as a proxy for inflation; the GDP deflator series; US Broad Money (M2); Three Month LIBOR rates; and the Three Month Treasury Bill rate. In some instances (specified in the Appendix) it was necessary to splice series.

Similar data were available for the UK. The equity market series were DataStream's UK total equity market index[5]; the Cazenove small cap stock series[6]; and the DataStream listed real estate company series. For direct, private real estate, the Jones Lang LaSalle indices were used. While these do not have the depth of capital of the Investment Property Databank series, there is a longer time-series available quarterly (IPD monthly running only from 1986). UK GDP; UK Industrial Output; Money Supply; Retail Price Index (excluding mortgage payments); the GDP Deflator; LIBOR Three month rate; Three Month Treasury Bill rate and Oil Prices provided macro-economic and monetary variables. Finally, the Morgan Stanley Capital Global Stock Index series and an IMF series for World Industrial Production provided a global perspective. A US Dollar, Pound Stirling exchange rate series was obtained to permit comparison across markets. All indices were set at 1.00 for first quarter 1982 to eliminate scaling effects; variables were logged for long run / levels analyses and differenced as appropriate.

In addition to the implied dividend yield series estimated from the total returns and capital appreciation series, a conditional volatility measure was estimated from the inflation data to provide a measure of price uncertainty (following Cochran & Defina, 1993; Lee, 1999; and Schwert, 1981). A univariate procedure is used to predict the level of prices (here an AR(4) process was utilised); the squared residuals are then modelled, once again using an autoregressive process, with the predicted values proxying for the

[4] Parallel results for the S&P 500 series are not reported.
[5] This is near identical to the FT All Share index.
[6] Neither the FT nor the DataStream series run back continuously to the 1970s.

conditional volatility (and hence the uncertainty) of prices. As might be expected, price uncertainty is strongly time varying, with conditional volatility values in the decade between 1973 and 1983 extremely high and more recent values (particularly in the UK) very low.

5.2 Stationarity and Co-integration

Summary statistics are shown in Appendix B for the variables (mainly in logs) and the first differences. The tests for stationarity show that all UK series are clearly I(1), that is are stationary in first differences, except the residual from the regression of the world stock series on the UK stock series, and so may be included in the tests for co-integrating relationships. The picture for the US is less clear and three variables, expected inflation, the direct property returns index and the money supply require comment. Both the log of the nominal property return index and the log of the money supply are I(2) using the Augmented Dickey-Fuller (ADF) test but I(1) using the Phillips-Perron (PP) test. The log of the expected inflation index appears to be I(1) when the level is tested using the ADF test but consideration of the first difference shows the result of stationarity to be highly sensitive to the number of lags used in the test. Using the PP test shows the levels series to be I(0) but the first differences to be I(1). Examination of the original inflation series and the other estimators not used in the main analyses reveals similar problems in all of the series. We assume that the problem series are I(1) and confirm the robustness of our results by consideration of co-integration of the chosen models and the stationarity of their errors, which may then be used in the short-run models. All of the preferred equations for both countries pass the tests for co-integration and for stationarity of the errors and so the ECM approach is validated (results available from authors on request).

6. Results

Before reporting the models, we first consider a variety of potential estimators of inflation to determine the best to be used in the modelling. The long-run and short-run models for the US and UK are then reported.

6.1 Estimators of Inflation

In this section, we consider the properties of our estimators and propose the use of one for each country in our subsequent analysis of inflation hedging using an error correction model. As outlined above, previous work has used a variety of methods to calculate expected inflation. The most commonly used are estimates derived from Treasury bill data. However, little attention appears to have been given to the properties of these estimators and the effect of estimator choice on the results. We propose that consideration is required of: lack of bias; efficiency; correlation with actual inflation; how close the constant in the regression of actual on expected inflation is to zero; and how close the coefficient in the regression of actual on expected inflation is to unity. Some of these are, of course, closely related.

We tested ten estimators of inflation for the US and the UK. These are:

1. The previous *ex post* real rate to derive the expected inflation from the T Bill (TB1_U).
2. An equally-weighted moving average of the previous two *ex post* real rates to derive the expected inflation from the T Bill (TB2_U).
3. An equally-weighted moving average of the previous three *ex post* real rates to derive the expected inflation from the T Bill (TB3_U).
4. An equally-weighted moving average of the previous four *ex post* real rates to derive the expected inflation from the T Bill (TB4_U).
5. An ARIMA model of the *ex post* real rates derived from the T Bill using a 40 quarter moving window (ARTB_U).
6. An ARIMA model of inflation using a 40 quarter moving window (ARIN_U).
7. The previous value of inflation (MA1_U).
8. An equally-weighted moving average of the previous two values of inflation (MA2_U).
9. An equally-weighted moving average of the previous three values of inflation (MA3_U).
10. An equally-weighted moving average of the previous four values of inflation (MA4_U).

Lack of bias, that is, on average, no statistical difference between the estimated value and the actual value, seems a desirable characteristic. Indeed, this might be expected in periods of relatively low and stable inflation. However, it could be argued that positive shocks are likely to be larger in magnitude than negative shocks, so a small positive bias might be expected.

As unexpected inflation is the difference between actual and expected inflation, we test whether the means of these series are significantly different from zero. The results, respectively for the US and the UK, are shown in Panel 1 of Tables 1 and 2. None of the estimators in either the US or the UK displays significant bias, although four in the US and five in the UK have negative point estimates. In both countries, these include all four simple moving averages (estimators 7-10). Estimator 6 has a much lower bias than the others in the US, while in the UK, estimators 1-3, 5, and 6 all have much lower bias than the others.

Efficiency is a relative concept and we would prefer the estimator with the lowest standard deviation of the error. Panel 2 shows the standard deviations of unexpected inflation. In both countries, estimators 1-5 (derived from the T Bill) are substantially less efficient than estimators 6-10. The latter group have standard deviations around two-thirds lower in the US and one-third lower in the UK.

A high correlation with actual inflation is a desirable quality of an estimator of inflation. Panel 3 presents these results. For the US, estimators 6-10 have similar correlations (in the range 0.82 to 0.84) and are higher than estimators 1-5 (0.63 to 0.75); for the UK, estimators 6 and 8-10 (0.67 to 0.70) are higher than the others (0.59 to 0.63).

Panel 4 considers the regressions of actual inflation on each of the estimators. In the US, the *constant in the regression* is not significantly different from zero only for estimators 8-10; and in the UK only for estimators 9 and 10. In both countries, the *coefficient in the regression* is always significantly different from zero. It is also significantly different from unity except for estimators 9 and 10 in the US and always in the UK, although estimators 9 and 10 are closest to unity.

Illustrative plots of estimated inflations versus actual inflation are shown in Figure 1. As a general rule, the US estimates are less affected by outliers.

An examination of the recursive coefficients (not shown here) reveals a remarkable temporal stability for the coefficient on all estimators in both the US and the UK, although for some there is an apparent trend in the constant.

The above analysis strongly suggests that estimators 9 and 10 are the best in both countries. There is little to choose between them and they correlate 0.99 in the US and 0.98 in the UK. Intuitively, a four-quarter moving average has more appeal than a three-quarter moving average, so we prefer the former. The results below use four-quarter moving averages of inflation rates as the measure for expected inflation. Other estimators yielded broadly similar results and are not reported in the paper.

6.2 The Models

In developing the final models, a wide range of explanatory variables was tried for each country. Variables tried but which do not feature in the final models were: the 90 day T-Bill, the inter-bank lending rate, the dollar-sterling exchange rate and real industrial output. We also used a conditional volatility variable (as explained in the Data section) as a measure of pricing uncertainty but it appears only in the UK direct property model and has marginal effect.

US long-run models

The US models are shown in Table 3. The long-run models (upper part of each Panel) all include expected inflation as a significant variable with a positive coefficient. For stocks it is significantly greater than unity and, for direct property, it is significantly less than unity, but for small cap stocks and REITs is not significantly different. The coefficient on unexpected inflation is always negative and significantly greater than unity. However, as the average value of the *rate* of unexpected inflation is only 0.03 percent per quarter compared to expected inflation at 1.1 per cent, this need not be of concern.

Real GDP also always features in the models with a positive coefficient significantly higher than unity. The index of world industrial output features only in the stock and REIT models, positively in the former and negatively in the latter, perhaps suggesting the attractiveness of real estate to investors when the wider environment is unfavourable. The money supply features only in the stock and small cap models, negatively in both and not significantly different from unity for small caps. Real US oil prices feature in all but the stock model and always with a positive coefficient significantly lower than unity. The residual from a regression of a world stock market index on US stocks features only in the direct property model.

US short-run models

Two sets of short-run results are reported for each asset class: a full model with the variables that are included in the long-run models as well of course as the error correction term and the dependent variable lagged by one quarter (middle part of each Panel) and a model with inflation components and significant variables only (bottom part of each Panel). The short-run models have a number of common features and some which distinguish direct real estate from the other investments. Generally the 'shock' explanatory variables have little impact. Real oil prices are the exception and feature where they are in the long-run models, either significantly or close to significance levels. Real GDP is significant only in the direct real estate model and none of the other variables features. The lagged return is significant only in the direct real estate model, where it is highly significant with a value of 0.59. The direct real estate result may suggest data issues with appraisals, or purchases based on appraisals, adjusting to recent actual inflation. This result may, therefore, be an artefact of the data (see Hendershott and MacGregor, 2006 for an analysis of the problems of the NCREIF dataset)[7].

Expected inflation is significant only in the direct real estate model where it is positive and significantly greater than zero and less than unity. In contrast, unexpected inflation features significantly in both the stock and small cap models and is negative and not significantly different from zero. There is therefore, very limited evidence of inflation hedging, although there is some evidence to suggest that real estate is better than other asset classes at hedging against expected inflation[8].

The error correction term is significant in all models but the magnitude of the coefficient ranges from 0.40 in the small caps model, to 0.19 in the stocks model and 0.17 in the REITs model to only 0.03 in the direct real estate model. Whereas the direct real estate model is driven by the lagged dependent variable, in all other models, the error

---

[7] An alternative approach would be to desmooth and de-lag real estate returns. There is sustained debate however in the literature as to how (and in fact as to whether) returns should be desmoothed (see Geltner *et al*., 2003 and Lai and Wang, 1998). We have opted for not taking the *a priori* view that smoothing is an issue and let the lagged return account for any such smoothing and lagging.

[8] Traditional Fama & Schwert (1977) regressions were also performed. The coefficients for direct, private property on both expected and unexpected inflation are significantly positive but less than unity. Coefficients for the other three asset classes are not significant. Consistent with the results reported in previous research, the R^2s are low.

correction is the driver. Thus the adjustment to unexpected inflation is not within period but lagged through negative feedback from the error correction.

UK long-run models

The UK models are shown in Table 4. They generally have more significant variables than the US models. All contain inflation as a significant variable with a positive coefficient. For direct property, it is significantly less than unity; for the others, it is significantly higher. The coefficient on unexpected inflation is always significant. It is negative for stocks and small stocks but positive for real estate shares and direct real estate. In none is its magnitude significantly different from unity. As for the US, the average value of the *rate* of unexpected inflation is low, only 0.08 per cent per quarter compared to expected inflation at 1.4 per cent.

Real GDP again features positively in all models, and with a coefficient significantly higher than unity for all models except real estate shares. The index of world industrial output features only in the stock model, where it has a positive coefficient not significantly different from unity, and in the direct real estate model, where it significantly different from unity in magnitude.

The money supply features negatively and not significantly different from unity in the stock and small caps models, and positively and significantly different from unity in the direct real estate model. This may indicate the attractiveness of property when the general fiscal climate is poor. Overall, the results are consistent with the US results.

Real US oil prices (in pounds sterling) feature in all models, negatively for stocks and real estate shares, but positively for small caps and direct real estate. In all cases, the coefficient is small in magnitude. These results vary from those in the US and show how different sections of the economy are differentially affected by oil prices, which have been a major source of export revenue in the UK. The direct property result may again indicate the attractiveness of property when the economic outlook for stock market is poor.

The residual from a regression of a world stock index on the UK stock market features positively in all models and is close to unity in all but direct property. This may indicate the impact of the world markets on the UK compared to the US market where the domestic market may tend to dominate.

UK short-run models

The short-run models have a number of common features and some which distinguish direct real estate from the other investments. As before, the 'shock' explanatory variables have little impact. The lagged return is significant only in the direct real estate model, where it is highly significant with a coefficient of 0.67.

Expected inflation and unexpected inflation are significant only in the direct real estate model where they are positive and significantly greater than zero and less than unity. Thus, only direct real estate exhibits inflation hedging characteristics, although this may again be due at least in part to the way the index is constructed.

The error correction term is significant in all models with similar coefficients of similar magnitude for all but direct property: 0.21 in the stocks model, 0.31 in the small caps model and 0.29 for real estate shares, compared to 0.12 in the direct real estate model. Again this is similar to the US, although the direct real estate market is more driven by the lagged adjustment through the error correction term than in the US. With the exception of direct real estate, the adjustment to inflation is not within period but lagged through negative feedback from the error correction. The direct real estate result may again be an artefact of the data.

7. Conclusions

Empirical evidence that equity markets provide a perverse hedge for inflation – particularly unexpected inflation – is generally explained in the literature in terms of the confounding impacts of real supply shocks and monetary shocks. Real supply shocks, other things equal, drive prices down but have a positive effect on stocks, generating an observed negative correlation; monetary shocks, by contrast, push inflation up but impose economic costs and may lead to interest rate changes. Findings are somewhat mixed in conventional inflation hedging frameworks, partly due to the difficulty of distinguishing long-run from short-run impacts and from the nature of transmission mechanisms.

Results for real estate assets are similarly mixed, with differences between the findings for public, listed real estate markets and private, directly-owned markets.

The results in this paper are based on an error correction mechanism approach that separately identifies long-run relationships and short-run adjustment processes. Inflation was included in the models, decomposed into anticipated and unexpected components, alongside a number of real and monetary variables. Different decomposition techniques were explored with the optimal model being based on a moving average univariate procedure. US and UK equity, small cap stock, public and private real estate returns were examined using quarterly data from 1977-2003.

For US markets, the long-run models all included expected inflation with a significantly positive coefficient. For private real estate, the coefficient was significantly less than unity. Real GDP was positively linked to returns, while money supply was negatively linked to equity and small cap returns but not to property returns. In all the short-run models, there was very little evidence of short-term adjustment to changes in inflation (either anticipated or unexpected). The error correction variable was positive and significant for all the public market assets and for direct property but with a much smaller magnitude. Adjustment was relatively slow – which provides confirmation for the argument that short-run analysis based on high frequency return data was unlikely to detect hedging qualities of assets. The short-run direct real estate model behaved differently from the public market models, with a lagged dependent variable playing a major role. This may result from the nature of the indices, but may also relate to the investment characteristics of the direct asset.

UK results were similar to the US results in many aspects. As expected, anticipated inflation was positively linked to asset returns in all four sectors, with only the private real estate coefficient being significantly less than unity. Unexpected inflation was negatively related to returns for equities and small cap stocks, non-significant (but positively signed) for listed property and significantly positive for private real estate. Real variables have positive effects; however, there appears to be a positive relationship of the (non-UK) world equity market, reflecting the different orientations of the US and UK economies. Money supply had a negative impact on returns for equities and small caps but a positive relationship with direct real estate. Direct real estate also behaved differently from the public market assets in the short-run models; it had positive significant coefficients for changes in anticipated inflation and positively signed coefficients for unexpected inflation indicating inflation hedging characteristics. This is consistent with the positive link to money supply in the long-run model. The direct real estate market short-run model is driven by a lagged dependent variable: as with the US market, this might point to data issues. For the public market assets, adjustment to changes in inflation takes place through the error correction mechanism: the magnitude of the ECM coefficients indicates that this is a gradual process.

The results here provide a broad confirmation of prior empirical and theoretical work on the relationship between asset returns, inflation, real output and monetary shocks. They demonstrate that, in both the UK and the US, public market asset returns are linked in the long-run to anticipated inflation but not to unexpected shocks in inflation, once the impact of real and monetary variables is considered. The ECM approach clearly demonstrates that asset return adjustment to changes in inflation does not occur in period but rather through an error correcting adjustment process to the long run relationship which is gradual. This has impacts on the way that inflation hedging attributes are measured and characterised. Finally the results do suggest that "real estate is different" – in both the long-run relationships and adjustment processes. While this is most evident for direct real estate, and hence may in part be dismissed as a data artefact, there are indications, particularly in the UK market of defensive qualities.

Table 1: Estimators of Anticipated Inflation: US Markets

PANEL 1:	US_TB1_U	US_TB2_U	US_TB3_U	US_TB4_U	US_ARTB_U	US_ARIN_U	US_MA1_U	US_MA2_U	US_MA3_U	US_MA4_U
Mean	0.00037	0.00054	0.00065	0.00076	0.00090	-0.00001	-0.00012	-0.00016	-0.00023	-0.00028
Standard Deviation	0.014	0.013	0.013	0.014	0.015	0.005	0.005	0.005	0.004	0.005
Observations	104	104	104	104	104	104	104	104	104	104
z-score	0.278	0.411	0.509	0.563	0.622	-0.015	-0.268	-0.355	-0.528	-0.625

PANEL 2:	US_TB1_U	US_TB2_U	US_TB3_U	US_TB4_U	US_ARTB_U	US_ARIN_U	US_MA1_U	US_MA2_U	US_MA3_U	US_MA4_U
Ratio error SD to error SD estimator 1	1.00	0.98	0.96	1.02	1.09	0.35	0.34	0.34	0.32	0.34

PANEL 3:	US_TB1_E	US_TB2_E	US_TB3_E	US_TB4_E	US_ARTB_E	US_ARIN_E	US_MA1_E	US_MA2_E	US_MA3_E	US_MA4_E
Correlation with actual inflation	0.66	0.69	0.74	0.75	0.63	0.82	0.83	0.82	0.84	0.83

PANEL 4:	US_TB1_E	US_TB2_E	US_TB3_E	US_TB4_E	US_ARTB_E	US_ARIN_E	US_MA1_E	US_MA2_E	US_MA3_E	US_MA4_E
Constant	0.008	0.007	0.007	0.007	0.008	0.002	0.002	0.001	0.001	0.001
Standard Error	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
t-stat (diff from 0)	10.897	11.323	11.908	12.685	11.454	2.177	2.261	1.660	0.997	0.955
Prob.	0.000	0.000	0.000	0.000	0.000	0.032	0.026	0.100	0.321	0.342

	US_TB1_E	US_TB2_E	US_TB3_E	US_TB4_E	US_ARTB_E	US_ARIN_E	US_MA1_E	US_MA2_E	US_MA3_E	US_MA4_E
Coefficient	0.301	0.317	0.331	0.320	0.271	0.844	0.832	0.865	0.909	0.904
Standard Error	0.034	0.032	0.030	0.028	0.034	0.058	0.056	0.059	0.058	0.061
t-stat (diff from 0)	8.794	9.760	10.950	11.497	8.095	14.643	14.895	14.595	15.668	14.745
Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
t-stat (diff from 1)	-20.420	-21.040	-22.117	-24.484	-21.751	-2.710	-3.017	-2.284	-1.567	-1.570

Table 2: Estimators of Anticipated Inflation: UK Markets

PANEL 1:	UK_TB1_U	UK_TB2_U	UK_TB3_U	UK_TB4_U	UK_ARTB_U	UK_ARIN_U	UK_MA1_U	UK_MA2_U	UK_MA3_U	UK_MA4_U
Mean	-0.00010	0.00004	0.00014	0.00037	0.00004	0.00004	-0.00026	-0.00031	-0.00044	-0.00056
Standard Deviation	0.014	0.015	0.015	0.017	0.015	0.009	0.011	0.009	0.009	0.009
Observations	104	104	104	104	104	104	104	104	104	104
z-score	-0.073	0.029	0.097	0.227	0.031	0.049	-0.238	-0.333	-0.515	-0.644

PANEL 2:	UK_TB1_U	UK_TB2_U	UK_TB3_U	UK_TB4_U	UK_ARTB_U	UK_ARIN_U	UK_MA1_U	UK_MA2_U	UK_MA3_U	UK_MA4_U
Ratio error SD to error SD estimator 1	1.00	1.04	1.08	1.19	1.04	0.65	0.80	0.68	0.63	0.64

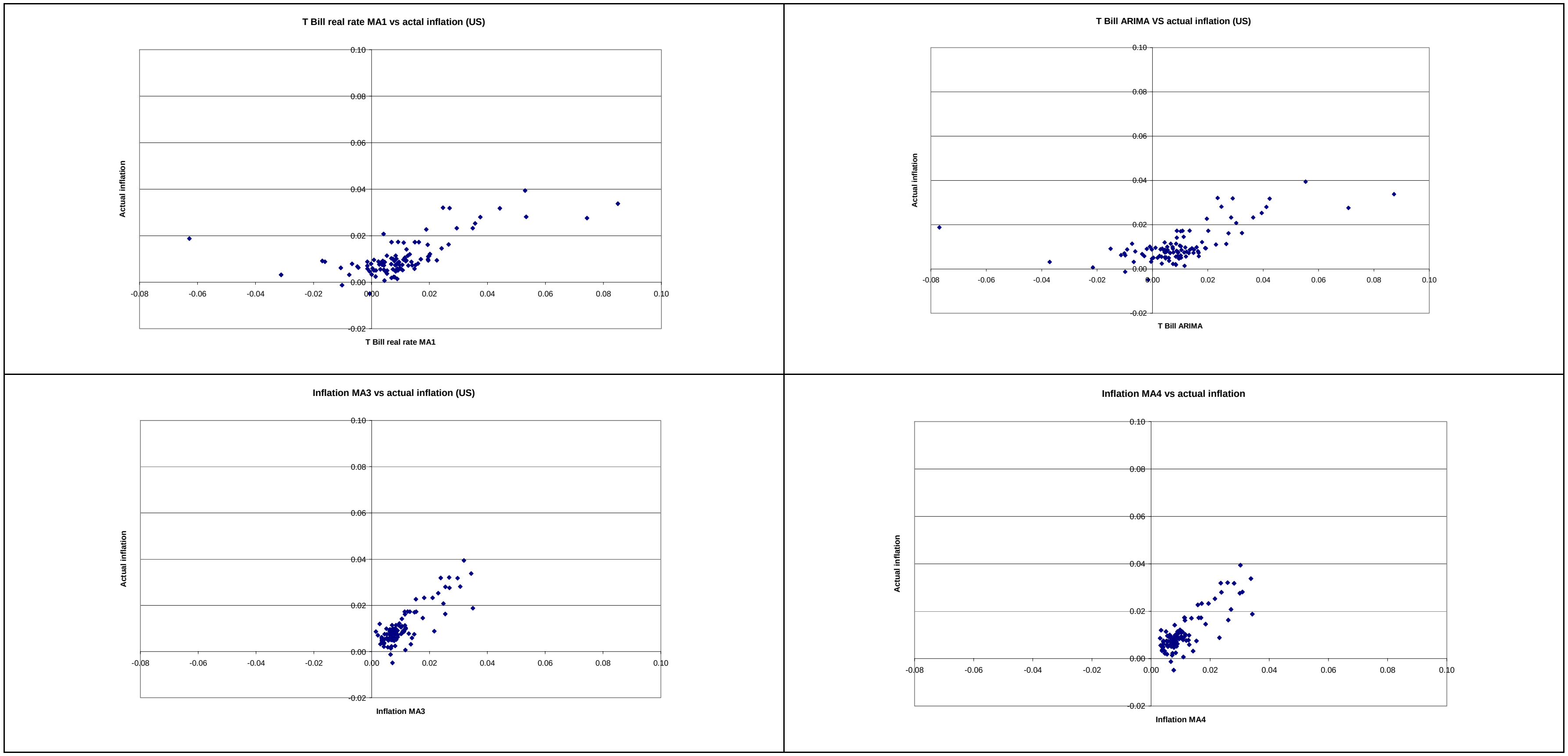
PANEL 3:	UK_TB1_U	UK_TB2_U	UK_TB3_U	UK_TB4_U	UK_ARTB_U	UK_ARIN_U	UK_MA1_U	UK_MA2_U	UK_MA3_U	UK_MA4_U
Correlation with actual inflation	0.59	0.61	0.63	0.62	0.59	0.70	0.59	0.67	0.72	0.70

PANEL 4:	UK_TB1_U	UK_TB2_U	UK_TB3_U	UK_TB4_U	UK_ARTB_U	UK_ARIN_U	UK_MA1_U	UK_MA2_U	UK_MA3_U	UK_MA4_U
Constant	0.008	0.008	0.008	0.009	0.008	0.003	0.005	0.003	0.002	0.002
Standard Error	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
t-stat (diff from 0)	6.187	6.677	7.218	7.833	6.570	2.175	3.655	2.146	1.400	1.358
Prob.	0.000	0.000	0.000	0.000	0.000	0.032	0.000	0.034	0.164	0.177

	UK_TB1_U	UK_TB2_U	UK_TB3_U	UK_TB4_U	UK_ARTB_U	UK_ARIN_U	UK_MA1_U	UK_MA2_U	UK_MA3_U	UK_MA4_U
Coefficient	0.425	0.409	0.399	0.358	0.407	0.782	0.591	0.754	0.828	0.821
Standard Error	0.057	0.053	0.048	0.045	0.055	0.079	0.080	0.082	0.080	0.082
t-stat (diff from 0)	7.390	7.707	8.289	7.887	7.409	9.907	7.398	9.237	10.385	9.975
Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
t-stat (diff from 1)	-10.015	-11.117	-12.505	-14.125	-10.807	-2.759	-5.117	-3.008	-2.152	-2.178

Figure 1: Actual Inflation versus Anticipated Inflation Estimator

(a) United States



(b) United Kingdom

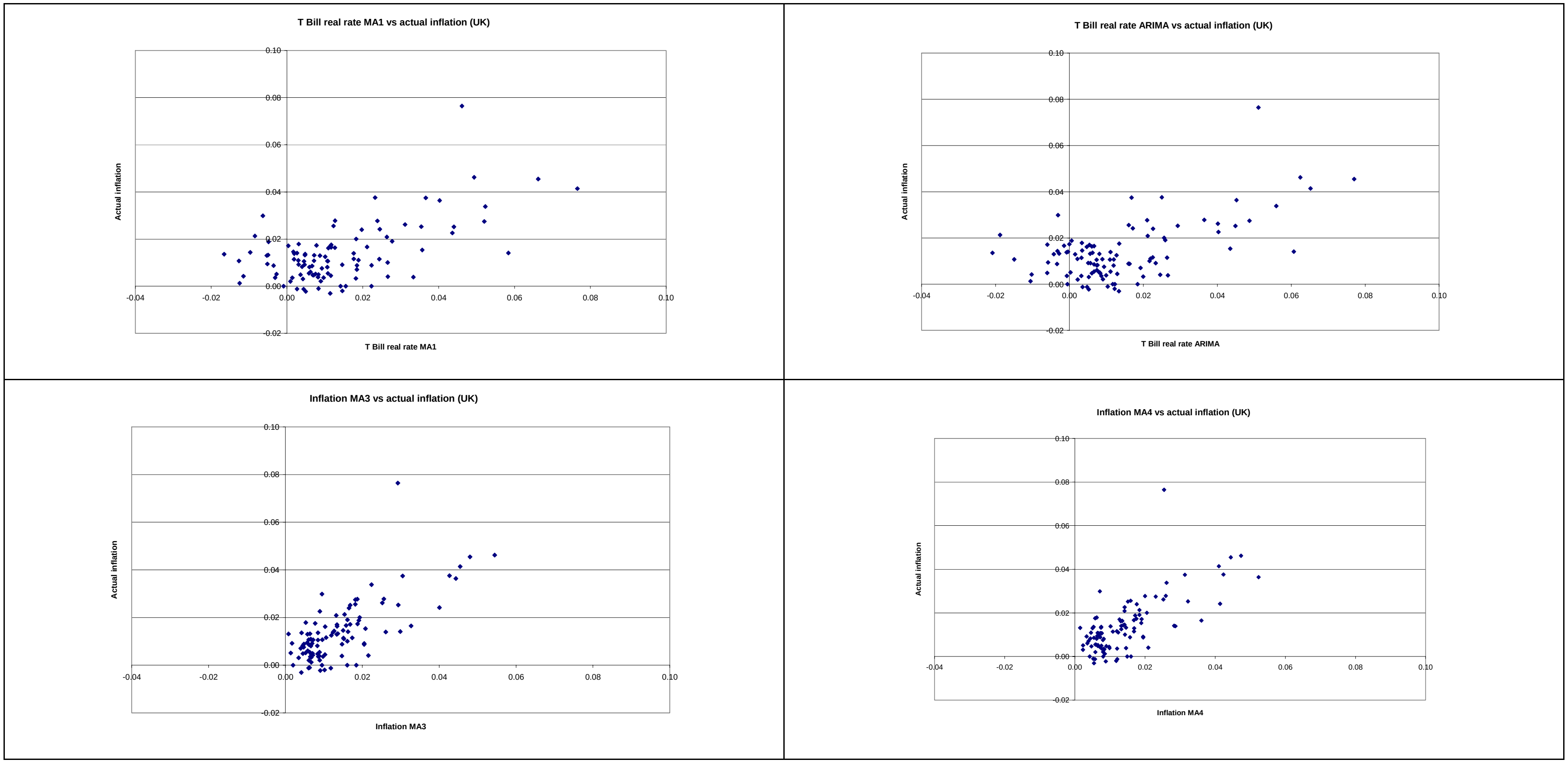


Table 3: US Long-Run and Short-Run Models

Panel 1: Stocks

Dependent Variable: LogSTRI (1977:4 2003:4)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.163	0.030	5.430	0.000
LogUS_MA4_E	1.820	0.258	7.042	0.000
LogUS_MA4_U	-6.193	1.335	-4.640	0.000
LogRGDPI	4.365	0.444	9.837	0.000
LogRWIOI	1.317	0.457	2.885	0.005
LogM2	-1.753	0.261	-6.719	0.000

Adjusted R-squared	0.985	Akaike info criterion	-1.062
S.E. of regression	0.138	Schwarz criterion	-0.910
Log likelihood	61.745	F-statistic	1387.101
Durbin-Watson stat	0.517	Prob(F-statistic)	0.000

Dependent Variable: dLogSTRI (1978:1 2003:4)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.022	0.021	1.030	0.306
dLogUS_MA4_E	0.166	1.193	0.140	0.889
dLogUS_MA4_U	-3.779	1.885	-2.004	0.048
dLogRGDPI	0.865	1.141	0.758	0.450
dLogRWIOI	0.231	0.216	1.070	0.288
dLogM2	-0.109	0.882	-0.124	0.902
ResSTOCKS(-1)	-0.188	0.063	-2.968	0.004
dLogNSTRI(-1)	0.072	0.105	0.684	0.495

Adjusted R-squared	0.057	Akaike info criterion	-2.155
S.E. of regression	0.079	Schwarz criterion	-1.952
Log likelihood	120.063	F-statistic	1.881
Durbin-Watson stat	1.978	Prob(F-statistic)	0.081

Dependent Variable: dLogSTRI (1978:1 2003:4)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.034	0.014	2.442	0.016
dLogUS_MA4_E	-0.234	1.095	-0.213	0.832
dLogUS_MA4_U	-3.365	1.714	-1.963	0.052
ResSTOCKS(-1)	-0.154	0.058	-2.669	0.009

Adjusted R-squared	0.071	Akaike info criterion	-2.207
S.E. of regression	0.079	Schwarz criterion	-2.105
Log likelihood	118.739	F-statistic	3.620
Durbin-Watson stat	1.854	Prob(F-statistic)	0.016

Panel 2: Small cap stocks

Dependent Variable: LogSCRI (1977:4 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.136	0.030	4.580	0.000
LogUS_MA4_E	1.484	0.226	6.565	0.000
LogUS_MA4_U	-4.606	1.342	-3.432	0.001
LogRGDPI	3.401	0.285	11.952	0.000
LogM2	-1.003	0.232	-4.318	0.000
LogRUSOILD	0.132	0.045	2.914	0.004
Adjusted R-squared	0.979	Akaike info criterion		-1.318
S.E. of regression	0.122	Schwarz criterion		-1.167
Log likelihood	75.209	F-statistic		984.295
Durbin-Watson stat	0.842	Prob(F-statistic)		0.000

Dependent Variable: dLogSCRI (1978:1 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	-0.008	0.024	-0.333	0.740
dLogUS_MA4_E	1.610	1.376	1.171	0.245
dLogUS_MA4_U	-4.341	2.350	-1.847	0.068
dLogRGDPI	2.186	1.340	1.632	0.106
dLogM2	-0.092	1.000	-0.092	0.927
dLogRUSOILD	-0.120	0.066	-1.826	0.071
ResSMALLCAPS(-1)	-0.405	0.090	-4.487	0.000
dLogNSCRI(-1)	0.094	0.104	0.908	0.366
Adjusted R-squared	0.218	Akaike info criterion		-1.881
S.E. of regression	0.091	Schwarz criterion		-1.678
Log likelihood	105.818	F-statistic		5.106
Durbin-Watson stat	1.967	Prob(F-statistic)		0.000

Dependent Variable: dLogSCRI (1978:1 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	-0.011	0.022	-0.490	0.625
dLogUS_MA4_E	1.619	1.338	1.210	0.229
dLogUS_MA4_U	-6.279	2.084	-3.013	0.003
dLogRGDPI	2.681	1.312	2.043	0.044
ResSMALLCAPS(-1)	-0.398	0.080	-4.992	0.000
Adjusted R-squared	0.212	Akaike info criterion		-1.900
S.E. of regression	0.091	Schwarz criterion		-1.773
Log likelihood	103.820	F-statistic		7.934
Durbin-Watson stat	1.908	Prob(F-statistic)		0.000

Panel 3: Securitised real estate

Dependent Variable: LogPSRI (1977:4 2003:4)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.127	0.029	4.318	0.000
LogUS_MA4_E	0.951	0.169	5.640	0.000
LogUS_MA4_U	-7.139	1.371	-5.206	0.000
LogRGDPI	2.426	0.328	7.400	0.000
LogRWIOI	-0.982	0.421	-2.335	0.022
LogRUSOILD	0.103	0.047	2.192	0.031

Adjusted R-squared	0.975	Akaike info criterion	-1.317
S.E. of regression	0.122	Schwarz criterion	-1.166
Log likelihood	75.154	F-statistic	819.646
Durbin-Watson stat	0.449	Prob(F-statistic)	0.000

Dependent Variable: dLogPSRI (1978:1 2003:4)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.027	0.016	1.713	0.090
dLogUS_MA4_E	0.485	0.963	0.504	0.616
dLogUS_MA4_U	-2.556	1.723	-1.483	0.141
dLogRGDPI	-0.917	0.959	-0.956	0.342
dLogRWIOI	-0.239	0.174	-1.374	0.173
dLogRUSOILD	-0.071	0.046	-1.532	0.129
ResPSTOCKS(-1)	-0.166	0.059	-2.789	0.006
dLogNPSRI(-1)	0.111	0.102	1.085	0.281

Adjusted R-squared	0.133	Akaike info criterion	-2.530
S.E. of regression	0.066	Schwarz criterion	-2.327
Log likelihood	139.559	F-statistic	3.258
Durbin-Watson stat	1.883	Prob(F-statistic)	0.004

Dependent Variable: dLogPSRI (1978:1 2003:4)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.018	0.012	1.555	0.123
dLogUS_MA4_E	0.787	0.922	0.853	0.396
dLogUS_MA4_U	-4.417	1.453	-3.040	0.003
ResPSTOCKS(-1)	-0.150	0.056	-2.702	0.008

Adjusted R-squared	0.118	Akaike info criterion	-2.548
S.E. of regression	0.066	Schwarz criterion	-2.447
Log likelihood	136.513	F-statistic	5.572
Durbin-Watson stat	1.823	Prob(F-statistic)	0.001

Panel 4: Real estate

Dependent Variable: LogPRRI (1977:4 2003:4)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	-0.020	0.017	-1.151	0.253
LogUS_MA4_E	0.557	0.110	5.060	0.000
LogUS_MA4_U	-3.507	0.782	-4.486	0.000
LogRGDPI	1.999	0.137	14.546	0.000
LogRUSOILD	0.262	0.029	8.956	0.000
ResSTONWO	0.652	0.065	10.038	0.000

Adjusted R-squared	0.984	Akaike info criterion	-2.291
S.E. of regression	0.075	Schwarz criterion	-2.140
Log likelihood	126.294	F-statistic	1286.928
Durbin-Watson stat	0.295	Prob(F-statistic)	0.000

Dependent Variable: dLogPRRI (1978:1 2003:4)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.003	0.003	1.007	0.316
dLogUS_MA4_E	0.354	0.191	1.856	0.067
dLogUS_MA4_U	-0.310	0.305	-1.017	0.312
dLogRGDPI	0.308	0.164	1.882	0.063
dLogRUSOILD	0.018	0.009	2.105	0.038
DResSTONWO	0.063	0.039	1.627	0.107
ResPROP(-1)	-0.034	0.017	-2.023	0.046
dLogNPRRI(-1)	0.590	0.080	7.378	0.000

Adjusted R-squared	0.497	Akaike info criterion	-5.968
S.E. of regression	0.012	Schwarz criterion	-5.763
Log likelihood	315.336	F-statistic	15.424
Durbin-Watson stat	2.528	Prob(F-statistic)	0.000

Dependent Variable: dLogPRRI (1978:1 2003:4)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.002	0.003	0.753	0.453
dLogUS_MA4_E	0.372	0.194	1.914	0.059
dLogUS_MA4_U	-0.104	0.281	-0.368	0.714
dLogRGDPI	0.318	0.165	1.933	0.056
ResPROP(-1)	-0.024	0.017	-1.468	0.145
dLogNPRRI(-1)	0.612	0.080	7.636	0.000

Adjusted R-squared	0.478	Akaike info criterion	-5.948
S.E. of regression	0.012	Schwarz criterion	-5.795
Log likelihood	312.338	F-statistic	19.704
Durbin-Watson stat	2.571	Prob(F-statistic)	0.000

Table 4: UK Long-Run and Short-Run Models

Panel 1: Stocks

Dependent Variable: LogSTRI (1977:1 2003:4)				
Variable	*Constantoefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.370	0.090	4.132	0.000
LogUK_MA4_E	1.877	0.184	10.204	0.000
LogUK_MA4_U	-2.816	0.974	-2.892	0.005
LRGDPI	2.071	0.630	3.289	0.001
LRWIOI	1.671	0.444	3.761	0.000
LM0	-0.848	0.283	-3.002	0.003
UKREAL	-0.020	0.008	-2.642	0.010
LRUSOILP	-0.100	0.053	-1.903	0.060
ResSTONWO	0.558	0.196	2.843	0.005
Adjusted R-squared	0.988	Akaike info criterion		-1.074
S.E. of regression	0.136	Schwarz criterion		-0.851
Log likelihood	67.016	F-statistic		1088.327
Durbin-Watson stat	0.755	Prob(F-statistic)		0.000

Dependent Variable: dLogSTRI (1977:2 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.043	0.019	2.306	0.023
dLogUK_MA4_E	-0.087	0.892	-0.098	0.922
dLogUK_MA4_U	-1.464	1.096	-1.335	0.185
dLogRGDPI	-2.115	1.301	-1.626	0.107
dLogRWIOI	0.111	0.256	0.433	0.666
dLogM0	-0.087	0.200	-0.435	0.664
dUKREAL	0.002	0.007	0.307	0.759
dLogRUSOILP	-0.135	0.055	-2.453	0.016
dResSTONWO	0.209	0.205	1.018	0.311
ResSTCKLEVEL(-1)	-0.212	0.072	-2.966	0.004
dLogNSTRI(-1)	0.142	0.110	1.289	0.201
Adjusted R-squared	0.091	Akaike info criterion		-2.041
S.E. of regression	0.083	Schwarz criterion		-1.767
Log likelihood	120.213	F-statistic		2.064
Durbin-Watson stat	1.943	Prob(F-statistic)		0.035

Dependent Variable: dLogSTRI (1977:2 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.025	0.014	1.851	0.067
dLogUK_MA4_E	0.619	0.774	0.800	0.425
dLogUK_MA4_U	-0.914	0.925	-0.988	0.326
dLogRUSOILP	-0.126	0.053	-2.398	0.018
ResSTCKLEVEL(-1)	-0.190	0.061	-3.094	0.003
Adjusted R-squared	0.108	Akaike info criterion		-2.112
S.E. of regression	0.082	Schwarz criterion		-1.987
Log likelihood	117.978	F-statistic		4.215
Durbin-Watson stat	1.807	Prob(F-statistic)		0.003

Panel 2: Small cap stocks

Dependent Variable: LogSCRI (1977:1 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.168	0.030	5.555	0.000
LogUK_MA4_E	1.775	0.157	11.323	0.000
LogUK_MA4_U	-2.906	0.937	-3.100	0.003
LRGDPI	2.374	0.556	4.267	0.000
LM0	-0.795	0.292	-2.719	0.008
LRUSOILP	0.119	0.054	2.203	0.030
ResSTONWO	1.597	0.179	8.918	0.000
Adjusted R-squared	0.975	Akaike info criterion		-1.001
S.E. of regression	0.142	Schwarz criterion		-0.827
Log likelihood	61.050	F-statistic		699.174
Durbin-Watson stat	0.742	Prob(F-statistic)		0.000

Dependent Variable: dLogSCRI (1977:2 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.017	0.020	0.819	0.415
dLogUK_MA4_E	1.011	0.966	1.047	0.298
dLogUK_MA4_U	-0.058	1.112	-0.052	0.959
dLogRGDPI	0.702	1.415	0.496	0.621
dLogM0	-0.580	0.181	-3.204	0.002
dLogRUSOILP	-0.085	0.060	-1.411	0.162
dResSTONWO	0.489	0.224	2.184	0.031
ResSMALLCAPS(-1)	-0.312	0.072	-4.355	0.000
dLogNSCRI(-1)	0.113	0.096	1.175	0.243
Adjusted R-squared	0.168	Akaike info criterion		-1.894
S.E. of regression	0.090	Schwarz criterion		-1.669
Log likelihood	110.312	F-statistic		3.678
Durbin-Watson stat	1.967	Prob(F-statistic)		0.001

Dependent Variable: dLogSCRI (1977:2 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.026	0.015	1.710	0.090
dLogUK_MA4_E	0.889	0.851	1.046	0.298
dLogUK_MA4_U	-0.364	1.012	-0.360	0.720
dLogM0	-0.546	0.180	-3.029	0.003
dResSTONWO	0.544	0.216	2.525	0.013
ResSMALLCAPS(-1)	-0.277	0.067	-4.156	0.000
Adjusted R-squared	0.166	Akaike info criterion		-1.917
S.E. of regression	0.090	Schwarz criterion		-1.767
Log likelihood	108.543	F-statistic		5.211
Durbin-Watson stat	1.810	Prob(F-statistic)		0.000

Panel 3: Securitised real estate

Dependent Variable: LogPSRI (1977:1 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.045	0.033	1.379	0.171
LogUK_MA4_E	1.558	0.127	12.313	0.000
LogUK_MA4_U	1.530	0.999	1.531	0.129
LRGDPI	1.276	0.237	5.377	0.000
LRUSOILP	-0.103	0.046	-2.242	0.027
ResSTONWO	0.925	0.191	4.833	0.000
Adjusted R-squared	0.971	Akaike info criterion		-0.834
S.E. of regression	0.155	Schwarz criterion		-0.685
Log likelihood	51.014	F-statistic		723.845
Durbin-Watson stat	0.629	Prob(F-statistic)		0.000

Dependent Variable: dLogPSRI (1977:2 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.013	0.023	0.552	0.582
dLogUK_MA4_E	0.676	1.094	0.618	0.538
dLogUK_MA4_U	0.886	1.290	0.687	0.494
dLogRGDPI	0.490	1.578	0.310	0.757
dLogRUSOILP	-0.097	0.067	-1.444	0.152
dResSTONWO	-0.096	0.248	-0.388	0.699
ResPSTOCKS(-1)	-0.287	0.075	-3.845	0.000
dLogNPSRI(-1)	0.181	0.100	1.803	0.075
Adjusted R-squared	0.092	Akaike info criterion		-1.655
S.E. of regression	0.102	Schwarz criterion		-1.455
Log likelihood	96.545	F-statistic		2.537
Durbin-Watson stat	1.934	Prob(F-statistic)		0.019

Dependent Variable: dLogPSRI (1977:2 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	0.019	0.017	1.103	0.273
dLogUK_MA4_E	0.507	0.962	0.527	0.599
dLogUK_MA4_U	0.576	1.150	0.501	0.617
ResPSTOCKS(-1)	-0.270	0.070	-3.869	0.000
dLogNPSRI(-1)	0.179	0.098	1.830	0.070
Adjusted R-squared	0.100	Akaike info criterion		-1.689
S.E. of regression	0.102	Schwarz criterion		-1.565
Log likelihood	95.387	F-statistic		3.930
Durbin-Watson stat	1.970	Prob(F-statistic)		0.005

Panel 4: Real estate

Dependent Variable: LogPRRI (1977:1 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	-0.241	0.033	-7.343	0.000
LogUK_MA4_E	0.806	0.065	12.396	0.000
LogUK_MA4_U	1.425	0.372	3.831	0.000
LRGDPI	2.300	0.228	10.075	0.000
LRWIOI	-0.444	0.155	-2.865	0.005
LM0	0.427	0.100	4.245	0.000
UKREAL	0.014	0.003	5.188	0.000
LRUSOILP	0.070	0.018	3.810	0.000
ResSTONWO	0.136	0.069	1.971	0.052
CONVOL	-203.459	78.547	-2.590	0.011
Adjusted R-squared	0.996	Akaike info criterion		-3.171
S.E. of regression	0.047	Schwarz criterion		-2.921
Log likelihood	179.638	F-statistic		3260.932
Durbin-Watson stat	0.570	Prob(F-statistic)		0.000

Dependent Variable: dLogPRRI (1977:2 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	-0.004	0.003	-1.072	0.287
dLogUK_MA4_E	0.491	0.171	2.876	0.005
dLogUK_MA4_U	0.379	0.207	1.833	0.070
dLogRGDPI	1.037	0.237	4.370	0.000
dLogRWIOI	0.064	0.047	1.355	0.179
dLogM0	-0.004	0.036	-0.121	0.904
dUKREAL	-0.001	0.001	-0.992	0.324
dLogRUSOILP	0.017	0.010	1.749	0.084
dResSTONWO	-0.066	0.038	-1.745	0.084
DCONVOL	-4.993	18.094	-0.276	0.783
ResPROPCV(-1)	-0.126	0.035	-3.569	0.001
dLogNPRRI(-1)	0.675	0.072	9.319	0.000
Adjusted R-squared	0.621	Akaike info criterion		-5.513
S.E. of regression	0.015	Schwarz criterion		-5.210
Log likelihood	301.427	F-statistic		16.484
Durbin-Watson stat	2.155	Prob(F-statistic)		0.000

Dependent Variable: dLogPRRI (1977:2 2003:4)				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	-0.002	0.003	-0.660	0.511
dLogUK_MA4_E	0.474	0.168	2.819	0.006
dLogUK_MA4_U	0.399	0.185	2.155	0.034
dLogRGDPI	0.999	0.216	4.634	0.000
dLogRUSOILP	0.020	0.010	2.057	0.042
ResPROP(-1)	-0.130	0.032	-4.015	0.000
dLogNPRRI(-1)	0.646	0.069	9.409	0.000
Adjusted R-squared	0.616	Akaike info criterion		-5.543
S.E. of regression	0.015	Schwarz criterion		-5.366
Log likelihood	298.028	F-statistic		28.825
Durbin-Watson stat	2.143	Prob(F-statistic)		0.000

Bibliography

Bakshi, G. and Chen, Z. (1996) Inflation, Asset Prices and the Term Structure of Interest Rates in Monetary Economies, *Review of Financial Studies,* 9, 241-276.

Balduzzi, P. (1995) Stock Returns, Inflation and the 'Proxy Hypothesis': A New Look at the Data, *Economic Letters,* 48, 47-53.

Barber, C., Robertson, D. and Scott, A. (1997) Property and Inflation: The Hedging Characteristics of U.K. Real Estate, *Journal of Real Estate Finance and Economics*, 15, 59-76.

Bodie, Z. (1976) Common Stocks as a Hedge Against Inflation, *Journal of Finance,* 31, 459-470.

Boudoukh, J. and Richardson, M. (1993) Stock Returns and Inflation: A Long-Horizon Approach, *American Economic Review,* 83, 1346-1355.

Boudoukh, J, Richardson, J. and Whitelaw, R. (1994) Industry Returns and the Fisher Effect, *Journal of Finance,* 49, 1595-1615.

Brueggeman, W., Chen, A. and Thibodeau, T. (1984) Real Estate Investment Funds: Performance and Portfolio Considerations, *AREUEA Journal,* 12, 333-354.

Chan, K., Hendershott, P. and Sanders, A. (1990) Risk and Return in Real Estate: Evidence from Equity REITs, *AREUEA Journal,* 18, 431-452.

Chatrath, A. and Liang, Y. (1998) REITs and Inflation: A Long-Run Perspective, *Journal of Real Estate Research,* 16, 311-325.

Chen, K. and Tzang, D. (1988) Interest Rate Sensitivity of Real Estate Investment Trusts, *Journal of Real Estate Research,* 3, 13-22.

Chen, S., Hsieh, C., Vines, T. and Chiou, S. (1998) Macroeconomic Variables, Firm-Specific Variables and Returns to REITs, *Journal of Real Estate Research,* 16, 269-276.

Chopin, M. and Zhong, M. (2001) Stock Returns, Inflation and the Macro-Economy: The Long- and Short-Run Dynamics, *Advances in Investment and Portfolio Management,* 8, 1-8.

Cochran, S. and Defina, R. (1993) Inflation's Negative Effects on Real Stock Prices: New Evidence and a Test of the Proxy Effect Hypothesis, *Applied Economics,* 25, 263-274.

Danthine, J. and Donaldson, J. (1986) Inflation and Asset Prices in an Exchange Economy, *Econometrica,* 54, 585-606.

Darnell, A.C. (1994) *A Dictionary of Econometrics*, Cheltenham, UK: Edward Elgar.

Darrat, A. and Glascock, J. (1989) Real Estate Returns, Money and Fiscal Deficits: Is the Real Estate Market Efficient? *Journal of Real Estate Finance and Economics,* 2, 197-208.

Ely, D. and Robinson, K. (1997) Are Stocks a Hedge Against Inflation? International Evidence Using a Long-Run Approach, *Journal of International Money and Finance,* 16, 141-167.

Fama, E. (1981) Stock Returns, Real Activity, Inflation and Money, *American Economic Review,* 71, 545-565.

Fama, E. and Gibbons, M. (1984) A Comparison of Inflation Forecasts, *Journal of Monetary Economics,* 13, 327-348.

Fama E. and Schwert, G. (1977) Asset Returns and Inflation, *Journal of Financial Economics,* 5, 115-146.

Firth, M. (1979) The Relationship Between Stock Market Returns and Rates of Inflation, *Journal of Finance*, 34, 743-749.

Fisher, I. (1930) *The Theory of Interest,* New York: MacMillan.

Geltner, D., MacGregor, B.D. and Schwann, G.M. (2003) Appraisal Smoothing and Price Discovery in Real Estate Markets, *Urban Studies*, 40, 1047-1064.

Geske, R. and Roll, R. (1983) The Monetary and Fiscal Linkage Between Stock Returns and Inflation, *Journal of Finance,* 38, 1-33.

Glascock, J., Lu, C. and So, R. (2002) REIT Returns and Inflation: Perverse or Reverse Causality Effects? *Journal of Real Estate Finance and Economics,* 24, 301-317.

Goebel, P.R. and Kim, K.S. (1989) Performance Evaluation of Finite-Life Real Estate Investment Trusts, *Journal of Real Estate Research*, 4, 57-70.

Gyourko, J. and Linneman, P. (1988) Owner-Occupied Homes, Income-Producing Real Estate and REIT as Inflation Hedges, *Journal of Real Estate Finance and Economics,* 1, 347-372.

Hartzell, D., Hekman, J., and Miles, M. (1987) Real Estate Returns and Inflation, *AREUEA Journal,* 15, 617-637.

Harvey, A.C. (1990) The Econometric Analysis of Time Series, London: Philip Allan.

Hendershott, P H and MacGregor, B D (*forthcoming* 2006) Investor rationality: an analysis of NCREIF commercial property data, *Journal of Real Estate Research*.

Hess, P. and Lee, B.S. (1999) Stock Returns and Inflation with Supply and Demand Disturbances, *Review of Financial Studies,* 12, 1203-1218.

Hoesli, M., MacGregor, B., Matysiak, G. and Nanthakumaran, N. (1997) The Short-Term Inflation-Hedging Characteristics of UK Real Estate, *Journal of Real Estate Finance and Economics,* 15, 27-57.

Jaffe, J. and Mandelker, G. (1976) The ‘Fisher Effect’ for Risky Assets: An Empirical Investigation, *Journal of Finance,* 31, 447-458.

Kaul, G. (1987) Stock Returns and Inflation, *Journal of Financial Economics,* 18, 253-276.

Kaul, G. (1990) Monetary Regimes and the Relationship Between Stock Returns and Inflationary Expectations, *Journal of Financial and Quantitative Analysis,* 35, 307-322.

Kaul, G. and Seyhun, H.N. (1990) Relative Price Variability, Real Shocks and the Stock Market, *Journal of Finance,* 45, 479-496.

Lai, T.-Y. and Wang, K. (1998) Appraisal Smoothing: The Other Side of the Story, *Real Estate Economics*, 26, 511-535.

Larsen, A, and McQueen, G. (1995) REITs, Real Estate and Inflation: Lessons from the Gold Market, *Journal of Real Estate Finance and Economics,* 10, 285-297.

Lee, B.S. (1989) Solving, Estimating and Testing a Nonlinear Stochastic Equilibrium Model with an Example of the Asset Returns and Inflation Relationship, *Journal of Economic Dynamics and Control,* 13, 499-531.

Lee, B.S. (1992) Causal Relations Among Stock Returns, Interest Rates, Real Activity and Inflation, *Journal of Finance,* 47, 1591-1603.

Lee, K. (1999) Unexpected Inflation, Inflation Uncertainty and Stock Returns, *Applied Financial Economics,* 9, 315-328.

Limmack, R. and Ward, C. (1988) Property Returns and Inflation, *Land Development Studies,* 5, 7-55.

Ling, D. and Naranjo, A. (1997) Economic Risk Factors and Commercial Real Estate Returns, *Journal of Real Estate Finance & Economics,* 14, 283-307.

Ling, D. and Naranjo, A. (1999) The Integration of Commercial Real Estate Markets and Stock Markets, *Real Estate Economics,* 27, 483-516.

Lintner, J. (1975) Inflation and Security Returns, *Journal of Finance,* 30, 259-280.

Liu, C., Hatzell, D. and Hoesli, M. (1997) International Evidence on Real Estate Securities as an Inflation Hedge, *Real Estate Economics,* 25, 193-221.

Marshall, D. (1992) Inflation and Asset Returns in a Monetary Economy, *Journal of Finance,* 47, 1315-1342.

Miles, M. and McCue, T. (1982) Historic Returns and Institutional Real Estate Portfolios, *AREUEA Journal,* 10*,* 184-199.

Murphy, J. and Kleiman, R. (1989) The Inflation Hedging Characteristics of Equity REITs: An Empirical Study, *Quarterly Review of Economics and Business,* 29, 95-101.

Nelson, C. (1976) Inflation and Rates of Return on Common Stocks, *Journal of Finance,* 31, 471-483.

Newell, G. (1996) The Inflation-Hedging Characteristics of Australian Property, *Journal of Property Finance,* 7, 6-20.

Park, J., Mullineaux, D. and Chew, I. (1990) Are REITs Inflation Hedges? *Journal of Real Estate Finance and Economics,* 3, 91-103.

Pilotte, E. (2003) Capital Gains, Dividend Yields and Expected Inflation, *Journal of Finance,* 58, 447-466.

Schwert, G. (1981) The Adjustment of Stock Prices to Information about Inflation, *Journal of Finance,* 36, 15-29.

Sirmans, C. and Sirmans, G. (1987) Real Estate Returns: The Historic Perspective, *Journal of Portfolio Management,* 13, 22-31.

Solnik, B. and Solnik, V. (1997) A Multi-Country Test of the Fisher Model of Stock Returns, *Journal of International Financial Markets, Institutions and Money,* 7, 289-301.

Stulz, R. (1986) Asset Pricing and Inflation, *Journal of Finance,* 41, 209-223.

Titman, S. and Warga, A. (1986) Risk and Performance of Real Estate Investment Trusts, *AREAUA Journal,* 14, 414-431.

Vanderhoff, J. and Vanderhoff, M. (1986) Inflation and Stock Returns: An Industry Analysis, *Journal of Economics and Business,* 38, 341-352.

Wurtzebach, C., Mueller, G. and Machi, D. (1991) The Impact of Inflation and Vacancy on Real Estate Returns, *Journal of Real Estate Research,* 6, 153-168.

Appendix A: Variables Used and Sources

Variables Used in Analysis of US Markets		
Variable	***Description***	***Source***
NSTRI	DataStream nominal return index all US equities	DataStream
NSTPI	DataStream nominal price index all US equities	DataStream
NSTDI	DataStream implied dividend index all US equities	Calculated
NPSRI	NAREIT nominal US REIT total return series	NAREIT
NPSPI	NAREIT nominal US REIT price return series	NAREIT
NPSDI	NAREIT implied US REIT nominal dividend index	Calculated
NSCRI	US Small Cap Stocks, nominal total returns	DataStream
NSCPI	US Small Cap Stocks, nominal price returns	DataStream
NSCDI	US Small Cap Stocks, implied nominal dividend index	Calculated
NPRRI	NCREIF nominal total real estate returns, all property	NCREIF
NPRPI	NCREIF nominal capital appreciation, all property	NCREIF
NPRINCI	NCREIF nominal income (net rent) series	NCREIF
NHOPI	US house price appreciation: Freddie Mac's Conventional Mortgage Home Price Index (CMHPI)	Freddie Mac
CPISA	Consumer Price Index, seasonally adjusted	Bureau for Labor Statistics
NUSOIL	Nominal price per barrel, US refiner acquisition cost of imported crude oil	US Dept. of Energy
NWORRI	Morgan Stanley Capital global stock index, nominal total returns	DataStream
NWOPI	Morgan Stanley Capital global stock index, nominal price returns	DataStream
NWODI	Morgan Stanley Capital global stock index, implied dividend series	Calculated
M2	Money Supply, M2 Broad money	DataStream
M0	Money Supply, M0 Narrow money	DataStream
TBill3	3 Month Treasury Bill (spliced series)	DataStream
LIBOR3	3 Month LIBOR rate	DataStream
RGDP	Real US GDP, seasonally adjusted, chained	Bureau for Economic Statistics
RINDI	Real US Industrial Production - total without exclusions	DataStream
RWIOI	Real World industrial output	IMF / ISDS
STERDOLL	Sterling dollar exchange rate	DataStream
ResSTonWO	Residual from regression of World equity return index on US equity returns – unique World factor.	Calculated.

Variables Used in Analysis of UK Markets		
Variable	***Description***	***Source***
NSTRI	DataStream nominal return index all UK equities	DataStream
NSTPI	DataStream nominal price index all UK equities	DataStream
NSTDI	DataStream implied dividend index all UK equities	Calculated
NPSRI	DataStream real estate sector nominal returns series	DataStream
NPSPI	DataStream real estate sector nominal price series	DataStream
NPSDI	Real estate sector implied dividend series	Calculated
NSCRI	Cazenove Small Cap Stocks, nominal total returns	DataStream
NSCPI	Cazenove Small Cap Stocks, nominal price returns	DataStream
NSCDI	Cazenove Small Cap Stocks, implied nominal dividend index	Calculated
NPRRI	Jones Lang LaSalle nominal total real estate returns, all property	JLL
NPRPI	JLL nominal capital appreciation, all property	JLL
NPRINCI	JLL nominal income (net rent) series	JLL
NHOPI	Nationwide quarterly house price index, mix adjusted, seasonally adjusted	Nationwide
RPIX	Retail price index, excluding mortgage payments, seasonally adjusted (spliced series)	Office for National Statistics
GDPDEF	GDP implied deflator	Office for National Statistics
NUSOIL	Nominal price per barrel, US refiner acquisition cost of imported crude oil	US Dept. of Energy
NWORRI	Morgan Stanley Capital global stock index, nominal total returns	DataStream
NWOPI	Morgan Stanley Capital global stock index, nominal price returns	DataStream
NWODI	Morgan Stanley Capital global stock index, implied dividend series	Calculated
M2	Money Supply, M2 Broad money	DataStream
M0	Money Supply, M0 Narrow money	DataStream
TBill3	3 Month Treasury Bill, discount, mid-rate	DataStream
LIBOR3	3 Month LIBOR rate	DataStream
RGDP	Real UK GDP, seasonally adjusted, chained	Office for National Statistics
RINDI	Real UK Industrial Production - total without exclusions	DataStream
RWIOI	Real World industrial output	IMF / ISDS
STERDOLL	Sterling dollar exchange rate	DataStream
ResSTonWO	Residual from regression of World equity return index on UK equity returns – unique World factor.	Calculated.

Appendix B: Summary Statistics

(a) US Markets: Levels

	Log NSTRI	Log NSCRI	Log NPSRI	Log NPRRI	Log US_MA4_E	Log US_MA4_U	Log RGDPI	Log RWIOI	Log M2	Log RUSOILD	Res STonWO
Mean	1.514	1.084	0.991	0.622	0.292	-0.014	0.316	0.200	0.516	-0.778	0.008
Median	1.492	0.989	0.933	0.698	0.348	-0.021	0.318	0.223	0.614	-0.913	-0.037
Maximum	3.292	2.502	2.403	1.643	0.701	0.047	0.717	0.470	1.231	0.190	0.340
Minimum	-0.419	-0.536	-0.571	-0.680	-0.422	-0.035	-0.072	-0.087	-0.336	-1.840	-0.199
Std. Dev.	1.138	0.846	0.774	0.593	0.306	0.019	0.235	0.162	0.423	0.477	0.135
Skewness	-0.070	-0.085	-0.298	-0.315	-0.657	1.643	0.034	-0.084	-0.342	0.447	0.952
Kurtosis	1.753	1.938	2.258	2.492	2.517	5.008	1.775	1.735	2.253	2.351	2.995
Jarque-Bera	6.894	5.058	3.970	2.868	8.570	64.901	6.585	7.126	4.487	5.333	15.869
Probability	0.032	0.080	0.137	0.238	0.014	0.000	0.037	0.028	0.106	0.069	0.000
Observations	105	105	105	105	105	105	105	105	105	105	105

(b) US Markets: Differences

	dLog NSTRI	dLog NSCRI	dLog NPSRI	dLog NPRRI	dLog US_MA4_E	dLog US_MA4_U	dLog RGDPI	dLog RWIOI	dLog M2	dLog RUSOILD	dRes STonWO
Mean	0.033	0.029	0.028	0.022	0.011	0.000	0.008	0.005	0.015	-0.037	-0.004
Median	0.045	0.046	0.022	0.023	0.008	0.000	0.008	-0.005	0.015	0.059	-0.011
Maximum	0.206	0.223	0.212	0.060	0.034	0.009	0.039	0.096	0.048	5.123	0.662
Minimum	-0.249	-0.298	-0.153	-0.055	0.003	-0.016	-0.020	-0.078	-0.009	-8.159	-0.617
Std. Dev.	0.082	0.103	0.071	0.017	0.007	0.005	0.008	0.039	0.010	1.361	0.154
Skewness	-0.762	-0.699	0.078	-1.085	1.621	-0.865	-0.213	0.554	0.195	-1.344	0.116
Kurtosis	3.996	3.716	3.168	7.288	4.858	4.462	6.035	2.736	3.477	16.772	7.614
Jarque-Bera	14.352	10.681	0.227	100.074	60.501	22.241	40.699	5.621	1.650	853.250	92.476
Probability	0.001	0.005	0.893	0.000	0.000	0.000	0.000	0.060	0.438	0.000	0.000
Observations	104	104	104	104	104	104	104	104	104	104	104

(c) UK Markets: Levels

	Log NSTRI	Log NSCRI	Log NPSRI	Log NPRRI	Log UK_MA4_E	Log UK_MA4_U	Log RGDPI	Log RWIOI	Log M0	Real Rate	Log RUSOILD	Res STonWO
Mean	1.493	1.012	0.992	0.741	0.373	-0.017	0.247	0.194	0.455	7.372	-0.751	-0.003
Median	1.661	1.205	1.221	0.874	0.478	-0.024	0.254	0.221	0.446	7.086	-0.909	-0.002
Maximum	3.152	2.331	2.255	2.076	0.889	0.070	0.581	0.470	1.283	13.893	0.132	0.199
Minimum	-0.806	-0.991	-1.072	-0.900	-0.628	-0.051	-0.042	-0.128	-0.365	2.178	-1.923	-0.166
Std. Dev.	1.217	0.882	0.897	0.790	0.416	0.028	0.188	0.165	0.416	2.932	0.508	0.085
Skewness	-0.377	-0.569	-0.485	-0.182	-0.754	1.511	0.111	-0.087	0.107	0.234	0.280	0.246
Kurtosis	1.881	2.292	2.104	2.070	2.548	4.902	1.790	1.751	2.098	2.022	2.027	2.622
Jarque-Bera	8.116	8.011	7.774	4.441	11.055	56.821	6.749	7.092	3.836	5.239	5.624	1.715
Probability	0.017	0.018	0.021	0.109	0.004	0.000	0.034	0.029	0.147	0.073	0.060	0.424
Observations	107	107	107	107	107	107	107	107	107	107	107	107

(d) UK Markets: Differences

	dLog NSTRI	dLog NSCRI	dLog NPSRI	dLog NPRRI	dLog UK_MA4_E	dLog UK_MA4_U	dLog RGDPI	dLog RWIOI	dLog M0	dReal Rate	dLog RUSOILD	dRes STonWO
Mean	0.035	0.029	0.031	0.028	0.014	-0.001	0.006	0.005	0.016	-0.011	-0.007	-0.000292
Median	0.046	0.042	0.030	0.027	0.012	0.000	0.006	-0.005	0.022	0.005	0.003	0.000542
Maximum	0.208	0.225	0.381	0.102	0.051	0.050	0.042	0.096	0.106	4.431	0.546	0.098453
Minimum	-0.324	-0.375	-0.248	-0.039	0.001	-0.020	-0.024	-0.078	-0.089	-3.625	-0.614	-0.121991
Std. Dev.	0.087	0.099	0.108	0.024	0.011	0.009	0.008	0.040	0.050	1.405	0.153	0.043498
Skewness	-0.980	-1.016	-0.112	0.144	1.469	1.535	-0.169	0.511	-0.462	0.129	-0.222	-0.290996
Kurtosis	5.130	5.086	3.380	3.762	4.783	11.753	7.891	2.693	2.288	3.599	6.021	2.974088
Jarque-Bera	37.027	37.460	0.859	2.932	52.151	379.996	106.143	5.027	6.016	1.877	41.168	1.498953
Probability	0.000	0.000	0.651	0.231	0.000	0.000	0.000	0.081	0.049	0.391	0.000	0.472614
Observations	106	106	106	106	106	106	106	106	106	106	106	106