Equities: what can they tell us about the real economy?

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Introduction

A feature of most industrialised countries in the recent past has been the strong growth in equity prices. This poses many questions to policymakers, chief amongst which are: what has led to the increase in equity prices, and what are the implications of significantly higher equity prices for the rest of the economy? This article draws together several disparate strands of research that attempt to address these issues and that are on-going at the Bank of England.

The next two sections focus on explanations of the increase in UK equity valuations. We first discuss the equity risk premium, with a view to finding out whether it has fallen in recent years compared to its long-run average. The main alternative explanation for higher equity prices is that expectations of future dividend growth have increased, and we discuss evidence relating to this hypothesis in Section 2.[1]

Thereafter we focus on the possible implications of the rise in equity prices. Monetary authorities may care about developments in equity prices for a variety of reasons. At the simplest level, equities may act as leading indicators for developments elsewhere in the economy. A priori this is a plausible supposition, given that a fundamental determinant of equity prices is expected future corporate earnings. An increase in equity prices, for example, driven by an upwards re-assessment of future corporate earnings might provide early evidence of a positive demand or supply shock. Or more structurally, as discussed in Section 3, changes in equity prices may themselves form part of the transmission mechanism of monetary policy. Changes in equity prices will change the net worth of both consumers and corporates, and such changes may have additional direct effects upon both consumption and investment, over and above those arising from the change in the cost of capital.

The maintained assumption throughout these three sections is that equity prices reflect fundamentals. We do not consider the possibility and implications of price bubbles, but focus on "no bubbles" analysis, that we think in general more instructive.[2]

In Section 4 we present some preliminary analysis of the leading indicator properties of equity prices in the United Kingdom, which is designed to clarify the informational content of equity market. The results in this section are largely incomplete however, and we discuss how we intend to extend this analysis.

Finally, in Section 5 we switch attention to stock option prices. We discuss how option prices can be utilised to extract the implied distribution of expected future stock prices at option

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1 The other possible explanation is a change in the discount rate which the market applies in valuing expected future earnings, and the discount rate could be affected directly by official interest rate changes.

2 There are a number of reasons, theoretical and empirical, to discount the likelihood of rational bubbles. From a theoretical angle, a negative bubble can never exist on an asset with limited liability, and a positive bubble can only exist if investors believe that there is no upper bound on stock prices. The latter rules out the possibility that firms issue more equity once the price reaches a certain level, thus effectively capping the stock price. Also, a bubble can *never* be zero. This means that if a bubble exists it must have always existed; and if it goes to zero, it can never re-start. Finally, note that rational bubbles are not predictable, and so cannot be proffered as an explanation for predictability in stock returns. From an empirical perspective, rational bubbles imply explosive behaviour in functions of prices and dividends that are not consistent with observed behaviour (see Campbell et al. (1997)).

maturity and may, therefore, themselves contain leading indicator information for equity prices. The final section summarises.

1. Equity risk premium

Many analysts are of the opinion that a substantial portion of the rise in the UK stock market may be due to the fall in the equity risk premium. The equity risk premium is the additional return investors require as compensation for bearing the risks associated with holding equities, compared with risk-free assets. A lower-risk premium on equities implies that agents will use a lower discount rate or required rate of return to discount future dividend payouts; *ceteris paribus*, this should mean that the market rate will rise. Additionally, a lower equity risk premium will lead to a fall in the equity cost of capital which might then induce higher investment spending by the corporate sector (this is discussed in more detail in Section 3 below).

We model the ex-ante evolution of the risk premium in order to find out whether the current level of the equity risk premium is lower than the historical average. To that end, we use a dynamic version of the CAPM model developed by Merton (1973). Merton's model involves a market with continuous trading, where investors' utility falls as expected volatility (measured by the instantaneous conditional variance of asset returns) increases. In equilibrium, there is a linear relation between the required return on the market portfolio over and above the risk-free interest rate (i.e. the market risk premium), and the conditional variance of returns on the market portfolio:

$$E_t(R_{t+1} - r_{t+1}) = \gamma\sigma_{t+1}^2 \tag{1}$$

where R_{t+1} is the required return on the market portfolio in period t+1, r_{t+1} is the risk free rate in period t+1 and σ^2_{t+1} is the conditional variance of returns on the market portfolio. E_t is the expectation formed using information available at time t. The coefficient γ is commonly interpreted as a measure of average risk aversion.

To implement equation (1), we need some measure of the expected market return variance. Following Nelson (1991) we use an EGARCH-M specification to model the conditional variance of excess returns:[3]

$$R_{t+1} - r_{t+1} = \gamma\sigma_{t+1}^2 + \varepsilon_{t+1} \tag{2}$$

$$\varepsilon_{t+1} = \sigma_{t+1} z_{t+1} \qquad z_{t+1} \sim iid(0,1)$$

$$\ln\sigma_{t+1}^2 = \alpha_0 + \alpha_1 \ln\sigma_t^2 + \theta z_t + \gamma(|z_t| - E|z_t|) \tag{3}$$

Since EGARCH models the *log* of the return variance, rather than the level, the variance will be positive regardless of the sign of the estimated parameters. A particularly attractive feature of EGARCH is that it allows for asymmetry in the response of the conditional variance to positive and negative shocks to returns. Assuming that $\gamma > 0$ (as it is usually found to be), if $\theta < 0$ the conditional variance will rise in response to an unexpected negative return. The response to a positive shock is, however, more complicated, and depends on the relative magnitudes of θ and γ. In particular, if $|\gamma| > |\theta|$ (which we find for all G7 economies), then although a positive shock will increase the

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[3] Expression (3) is an ad hoc functional form designed by Nelson to capture the salient features of the data.

conditional variance, the rise will be less than that following a negative shock. The innovations z_t are assumed to follow a conditional General Error Distribution (GED). The GED allows for fatter tails than the normal distribution, which is a salient characteristic of stock market data.

We estimate the risk premium for the UK market as well as other major stock markets – US, German and French – to assess the extent to which premia are correlated across markets. We use daily returns data on the Datastream Total Markets Index[4] from 1st January 1981 to 8th December 1997 for the four countries. Three-month Euromarket rates were used as "risk-free" interest rates.

Chart 1 shows estimated UK and US risk premia. In both cases, although the risk premium was lower in 1995-96 than in previous years, it has risen again in 1997.

Chart 1

UK and US equity risk premia

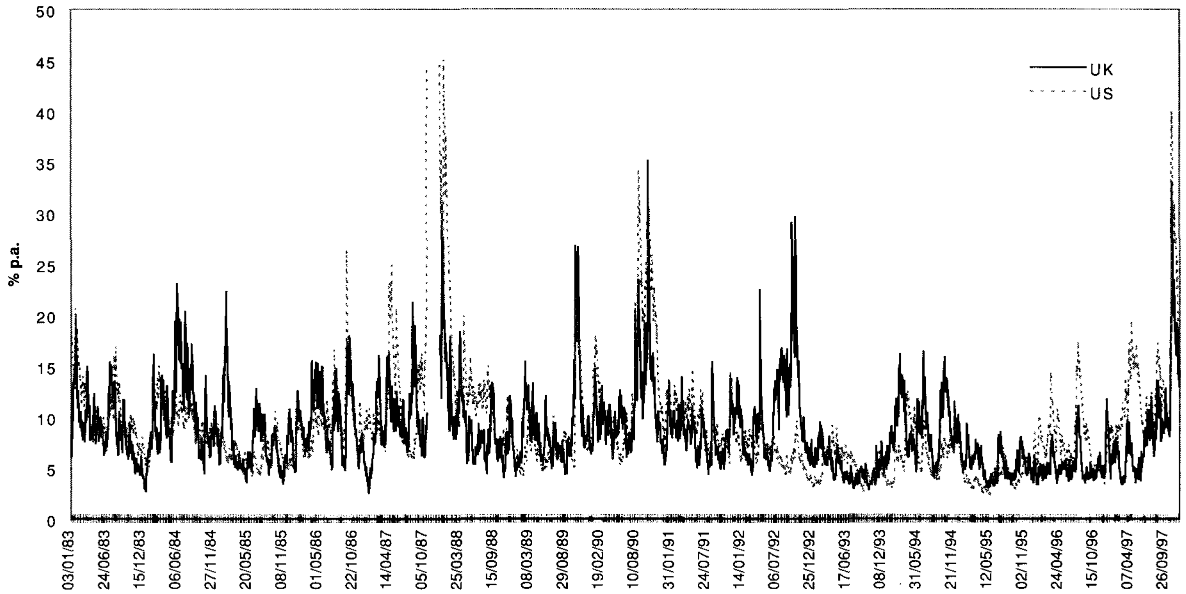

Chart 2 shows risk premia for Germany and France. They appear highly correlated, as one would expect for economies whose real and financial sectors are closely integrated. For both countries, there is no clear downward trend. But the market has been more tranquil in the 1990s, so that the risk premium is around the lower end of its range over the period.

The suspicion that the equity risk premium has fallen world-wide in recent years is not borne out by this analysis. This may be due to the high degree of persistence in volatility expectations, which means that expected volatility would fall only if actual volatility were very low for a protracted period of time.[5]

A major caveat to the above conclusion is that the standard EGARCH-M model used here assumes that the risk aversion coefficient γ is constant over time. This coefficient measures investors' willingness to bear risk. If investors have become more tolerant of risk in recent years, we would see a fall in the value of the risk aversion coefficient. For a given level of expected volatility,

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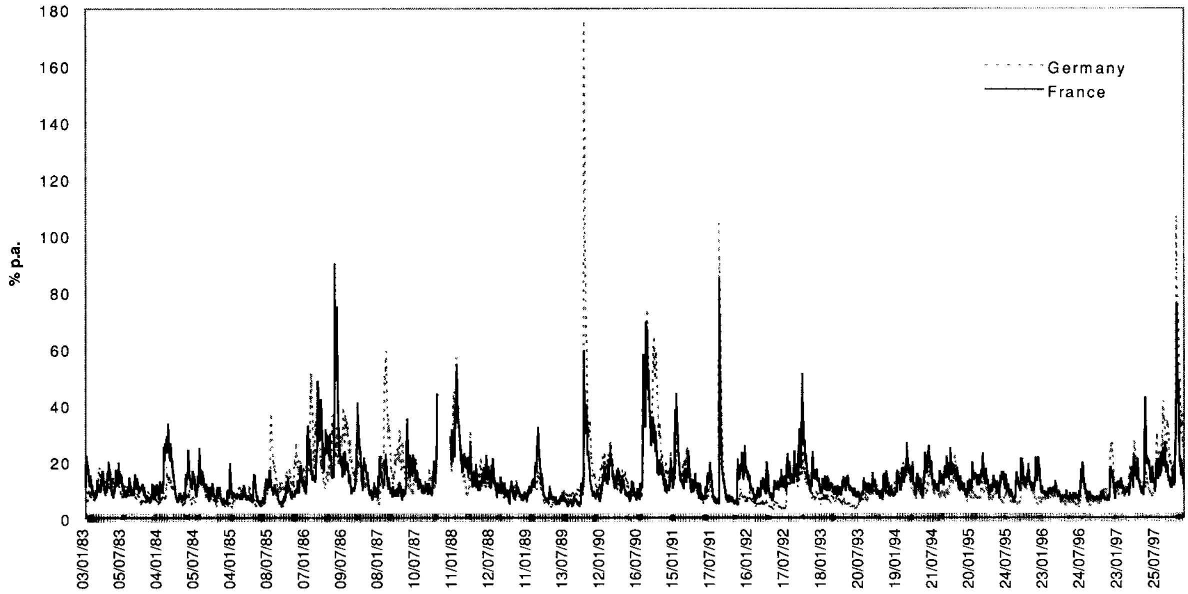
4 The Datastream Total Market Indices are broad equity indices, comprising the 1,000 largest stocks in terms of their market capitalisation for each country.

5 For example, Chen (1988) finds that the conditional variance of US stock returns can be usefully characterised as an integrated GARCH process.

this would lead to a decline in the equity risk premium. The conclusion that the risk premium has not declined may therefore be an artefact of this constancy assumption. Notwithstanding the above caveat, it appears unlikely that the current behaviour of the risk premium can explain much of the recent rise in the equity markets.

Chart 2

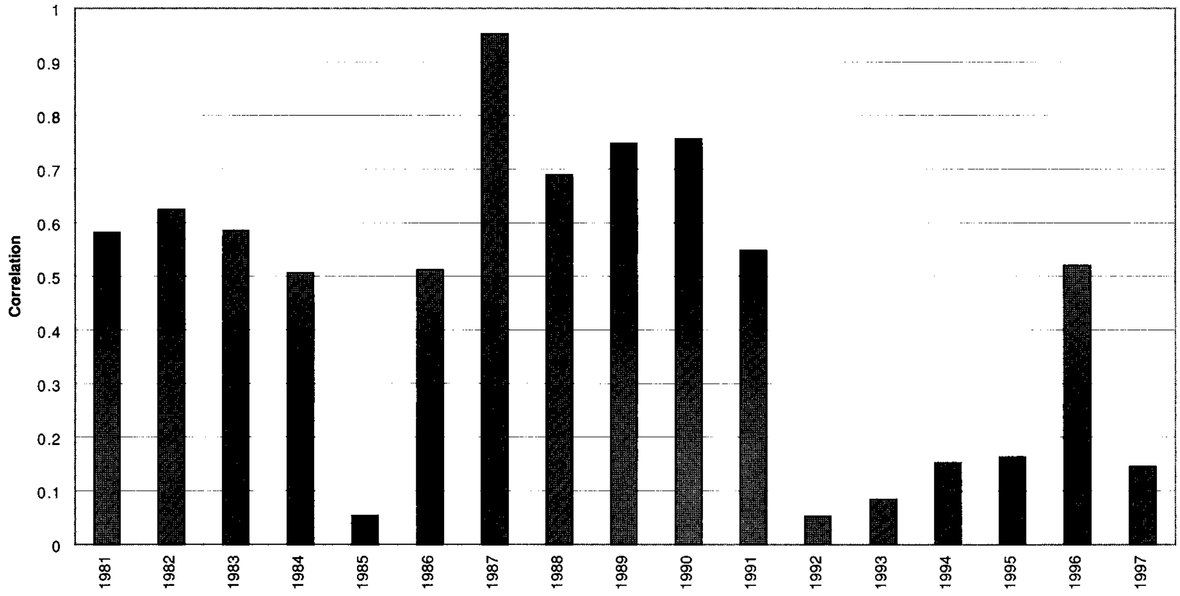
French and German equity risk premia



Looking at the correlations between equity risk premia, the UK market is very highly correlated with the United States and Canada, with full-sample correlations of around 90%. Within the G7, the United Kingdom is least correlated with the Italian market, with a correlation coefficient of 29%. However, these correlations are quite variable over time. Chart 3 shows the correlations between UK and US risk premia for each year from 1981 to 1997. The highest correlation was 95% in 1987 (when all G7 equity markets were highly correlated), but only 5% in 1985 and 1992.

Chart 3

Correlation between UK and US equity risk premia



2. Dividend growth forecasts using the Gordon Growth Model

This section looks at how we can extract market forecasts of future dividends from current equity prices. These can be compared with past dividend performance to gauge whether investors currently hold optimistic views compared with the historical performance of dividends.

The Gordon Growth Model provides a simple equation for linking the stock price to expected future dividends.

The Gordon Growth Model

The present-value formula for the price of a stock states that the current stock price P_t is the discounted present value of expected future dividends, D_t, where each dividend is discounted by the required return (or opportunity cost of capital), K, which we assume to be constant. So if we are currently in time 0, the stock price P_0 is:

$$P_0 = E_0\left[\frac{D_1}{1+K}+\frac{D_2}{(1+K)^2}+\frac{D_3}{(1+K)^3}+\cdots\right] \tag{4}$$

where E_t denotes expectations formed at time t.

Equation (4) can be simplified if we assume that dividends are expected to grow at a constant rate g. In this case, we can write all future dividends as a function of the current-period's dividend, D_0. Specifically, $D_1=(1+g)D_0$, $D_2=(1+g)^2D_0$ and so on. As long as $g<K$, we obtain the Gordon Growth formula:

$$P_0 = \frac{(1+g)}{(K-g)}D_0 \tag{5}$$

The simplest expression for g from (5) is:

$$g = \rho K - (1-\rho) \tag{6}$$

where $\rho \equiv \left(1+\frac{D_t}{P_t}\right)^{-1}$

Estimating the required return

For each individual equity or equity index we obtain the dividend-price ratio, and therefore ρ, from Datastream. The required return K, on the other hand, needs to be estimated. Equation (6) indicates that the estimate of K is extremely important for the resultant growth estimate. Although ρ is less than 1, it is generally in the range 0.95-0.99. From equation (6), this implies that a one-unit rise in K is associated with a near-one-unit rise in g. The estimate of g is therefore extremely sensitive to the estimated required return K.

We use two methods to estimate K. First, the CAPM equation, which posits a linear relation between the required return on each asset and the required return on the market portfolio, can be used to derive the required return on each stock (labelled $K1$). The resultant growth estimates are labelled $g1$ in Table 1.

Table 1

Dividend growth estimates, 4th September 1997

Sector	*R*	*K*1 (%)	*g*1 (%)	*K*2 (%)	*g*2 (%)	Past growth (%)
Financial	0.970	26.19	22.45	32.59	28.67	11.31
Mineral Extraction	0.970	19.36	15.77	25.30	21.53	10.74
General Industrials	0.963	17.37	13.03	9.91	5.84	4.82
Consumer Goods	0.969	15.22	11.62	14.38	10.80	7.13
Services	0.972	17.05	13.75	14.60	11.37	9.26
Utilities	0.959	14.99	10.29	16.54	11.76	7.65
House Building	0.967	43.80	38.13	16.94	13.14	n/a (see notes)
Construction	0.966	36.78	32.14	14.93	11.04	n/a (see notes)

Notes: r is as defined in equation (4). $K1$ is the estimated cost of capital using the CAPM as the model for required returns, and $g1$ is the associated expected dividend growth rate, calculated using equation (4). $K2$ is the average ex post return over the previous five years, and $g2$ is its associated dividend growth rate. Past Growth is the average rate of ex post dividend growth over the previous five years. Lack of historical data means that Past Growth figures are not available for House Building and Construction.

The second method is to obtain a model-free estimate of the required return by simply taking the average return on an asset over the previous five years. The intuition here is that if investors are rational, the realised return should differ from the expected return only by a white noise error term. Since positive and negative errors will cancel out over a long period of time, the average realised return should equal the (constant) expected return. This procedure results in the required return estimates $K2$, which produces the growth estimates $g2$.

Dividend growth estimates

Table 1 shows the results for the Datastream Industry-based portfolios, for data at the close of the market on Wednesday 4th September. The risk-free rate is taken to be the one-month Treasury bill yield, and the expected return on the market portfolio is calculated using the Datastream Total Market Index. The average Treasury bill yield over the past five years was 6.1%, while the average excess return on the market was 11.3%. These are the figures used in the CAPM calculations.

As mentioned above, the dividend growth forecasts depend crucially on the required return estimates. Looking at the columns headed $K1$ and $K2$, there appears to be little relationship between the two: neither is consistently higher or lower than the other, and some of the differences are extremely large. For example, for House Building the CAPM estimates $K1$=43.8%, whereas the average return over the previous five years was 16.9%. Mineral extraction, on the other hand, actually returned on average 25.3%, whilst the CAPM estimate is 19.4%. Such differences will inevitably result in differences in the growth estimates.

However, it is still possible to draw consistent inferences concerning the implications of the growth estimates for the appropriateness of current equity prices. For the Financial sector $g1$ and $g2$ are estimated as 22.5% and 28.7% respectively. Although these differ by a substantial 6%, they are both more than twice the rate at which dividends have grown on average over the previous five years, 11.3%. For Mineral Extraction, Consumer Goods, Services and Utilities, the expected future dividend growth figures are generally between one-and-a-half and twice those seen in the previous five years.

For three of the sector portfolios – General Industrials, House Building and Construction – the difference between the two growth estimates is too large for reliable inference to be drawn: the estimates range from 5.8% to 13% for General Industrials; from 13.1% to 38.1% for House building; and from 11% to 32.1% for Construction. In particular, for General Industrials the $g2$ figure of 5.8% is not too far from the past growth figure of 4.8%; but the $g1$ estimate of 13% clearly indicates stronger dividend expectations than had previously been seen.

The evidence here suggests that investors expect around twice the rate of dividend growth in the future than has been seen in the recent past. If correct, the issue is why have investors so adjusted their expectations. There are, however, two important caveats to remember. First, since the Gordon Growth Model is a steady-state model, the results will be misleading to the extent that the equity market is not in steady state.[6] Second, the results are sensitive to the estimate of the required return, K. If we have consistently overestimated the equity cost of capital, then the procedure adopted here will inevitably lead to the erroneous conclusion that the market is over-valued.

3. What type of information can we extract from equities?

The Modigliani-Miller (MM) theorem, on some strong assumptions, suggests that, the financial structure of a firm is irrelevant. Financial structure has no impact upon corporates' net worth, and should not influence their real decision making (i.e., how much to produce, invest etc). In as much as the MM theorem holds, there is no theoretical explanation why financial structure should be causally linked to firms' behaviour. The implication is that the equities are of interest only if they exhibit reliable (atheoretic) leading indicator relationships. But more modern finance theories (for example, Myers and Majluf (1984)) that stress the importance of imperfections in capital markets, suggest that these imperfections may influence the real activities of firms. The "credit view" of the monetary transmission mechanism has built upon this analysis, and suggests that at a macro-economic level, changes in equity prices may have quantitatively important effects upon corporate sector behaviour. If these credit effects matter, equity price movements may have a structural, rather than merely leading indicator, relationship with corporate sector activity.

For individuals, the theoretical underpinnings are clearer: life cycle theories suggest that wealth should be an important determinant of individual's consumption decisions, and equities (along with housing) form the main component of individuals' wealth holdings.[7]

This section reviews theory and evidence that equity price changes may have a causal impact on corporate sector activity. We couch this analysis in terms of the contribution of equities to the propagation of monetary shocks – reflecting the particular focus of central banks – but the conclusions are applicable across a wider range of shocks.

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6 Steady state means that dividend growth and the discount factor applied to dividends are expected to be constant, which underlies the derivation of the Gordon Growth Model. The Bank is currently undertaking research into using the Campbell-Shiller dividend-price ratio model as an alternative framework for deriving profit expectations from equity prices. This is a dynamic version of the Gordon Growth Model that does not require the assumption that the market is in steady state.

7 Less clear, however, are the quantitative importance of (equity) wealth effects upon consumption, and whether changes in the distribution, and form of holding equity wealth over the last decade or so have strengthened or weakened this relationship. Although an interesting issue, we leave this to one side here.

The monetary transmission mechanism and corporates: the role of equities

Theory

Traditional views of the transmission mechanism, as embodied in IS-LM analysis, focus upon the power of monetary policy to change the real cost of capital in the short-run. Changing the cost of capital alters the returns from savings and investment, and so the level of real output. Such models typically do not model the equity market. Implicitly any change in equity prices are viewed as an endogenous response to the changes in real activity brought about by the cost of capital channel: in these models equity prices may change, but there is no additional effect from this over and above that brought about by the change in the bond prices.

This traditional model has been extended to include additional assets markets (e.g. Brunner and Meltzer (1972)). The extended models imply a richer transmission mechanism for monetary shocks, with the output effect now depending on the interaction of multiple (two in the case of Brunner and Meltzer) asset markets and output.

But all of these traditional views implicitly assume that capital markets are perfect. By contrast, the "credit view", which has been developed by Bernanke, Gertler, Gilchrist and others over the last ten years or so, stresses the contribution of capital market imperfections to the transmission mechanism.[8] The focus has been on the role of information gaps in capital markets, rather than the more tangible distortions brought about by the tax system and transactions costs.

Information gaps arise because it is difficult and costly to monitor the state of firms. This can create principal-agent problems between both debt and equity holders and managers. There is a substantial literature which details the precise nature of these problems (see Gertler (1988) and Gertler and Gilchrist (1993) for surveys). Its main conclusions are well known. First, it is in the interests of lenders to place restrictive covenants on firms' behaviour, to ensure that firm managers do not act against the lenders' interests. Second, the restrictiveness of these covenants is likely to increase as the debt to equity ratio of a firm increases. Third, firms will have to pay a premium for new equity issues, if the attempt to issue new equity is likely to be interpreted as signalling that management believe prevailing market value of equity is unwarrantedly high. This is likely if managers have more information about the state/value of a firm than shareholders,[9] and alternative forms of finance are available.[10]

These arguments underpin the famous "pecking order theory of finance" (Myers and Majluf (1984)) which suggests that when such information gaps are germane, firms will find that internal finance is cheaper than external finance, and within that new debt will tend to be cheaper than new equity. These theories suggests two further channels of monetary transmission over and above the simple cost of capital channel (Bernanke and Gertler (1995)).

First, there will be a *balance sheet*, or *net worth* channel. This rests upon the assumption that the size of the premium attached to external over internal finance – the external finance premium – will increase as the net worth of a firm decreases. The intuition is that a stronger financial position reduces the potential conflict of interest between a manager and the debt holder. For example, as the

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8 The seminal article which underpins much of the credit chanel literature is Stiglitz and Weiss's (1981) analysis of equilibrium credit rationing.

9 Managers will have an incentive to issue shares if the current share price over-values the firm, as equity finance will then be cheap; conversely, managers have no incentive to issue shares when the current share price under-values the firm. This is an example of the famous "lemons" problem.

10 Some firms, for instance high growth firms, may not have to pay a premium as they credibly argue that current cash flows would be unable to finance expansion and that (sufficient) debt is not available.

net worth of a firm in financial distress improves there is less incentive for managers (assuming they maximise equity-holders returns) to undertake negative net present value projects which offer a small probability of a very large return.[11]

Bernanke and Gertler (1995) argue that equities may play a causal role here. Monetary shocks are likely to change equity prices, and in so doing will change the value of borrowers' collateral, which in turn is likely to change firms' perceived credit-worthiness and so the premium charged on new loans.[12] The result is the so-called "financial accelerator" (Bernanke, Gertler and Gilchrist (1994)): the initial impact of, for example, a negative shock to production and investment from the cost of capital channel will reduce net worth. This will increase the external finance premium, amplifying the cost of capital effect upon activity.

The importance of this accelerator is likely to be greater in recessions than in booms. The reason is that there is a lower bound of zero on the external finance premium. When the economy is in good shape, borrowers may charge a lower premium than during recessionary periods, on the basis that the general riskiness of lending has fallen.

The second additional channel of transmission is the *bank lending* channel. This will be relevant if there are agents for which the only form of external finance available is bank debt. This may occur if the information gap is especially significant for some classes of agents (for example small firms and individuals) and banks have specialised at gathering and processing information about such borrowers. If this is the case, and if monetary shocks alter the relative cost of loanable funds for banks, then the transmission of the monetary shock through to bank-dependent borrowers will reflect both the basic cost of capital element, and the change in the relative price of bank debt.[13]

Evidence

The importance of the balance sheet effect is likely to vary across classes of firm. The creditworthiness of mature firms with stable earnings is easier to assess for instance, than that of high growth, new technology firms (for example, IT software houses). Accordingly, empirical studies have tended to investigate whether there is evidence of cross-sectional or time series variation across classes of firms' behaviour that is consistent with a balance-sheet channel. Schianterelli (1996) provides an excellent summary of the literature.

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[11] Imagine a firm has very low net worth and is likely to go bankrupt. If bankruptcy occurs the equity holders will receive nothing – debt holders get the first claim on bankrupt companies. Thus, there is an incentive to undertake very risky projects, on the off chance that they will generate sufficiently large returns to make the company profitable again. By contrast, if the net present value of such risky projects is actually less than zero, then the debtholders' expected return will be reduced further by investment in risky projects. And conversely, if there is a very safe project, which is likely to make money, but leaves the company still insolvent, there would be no benefit to equity holders from investing in the project, even though it would increase the expected return to debt holders.

[12] Suppose a monetary shock (rise in interest rates) decreases equity prices. If a firm's debt is fixed rate then its value will be unchanged and the debt/equity ratio will rise. Alternatively the debt may be floating rate; in this case the value of debt interest payments and the debt will rise. Now the rise in the debt/equity ratio will be even greater, as equity value will have fallen and debt value will have risen. Thus whatever form existing debt takes, potential new lenders will observe a fall in the available collateral for new loans.

[13] This second element of the credit channel is more controversial. For example, Romer and Romer (1990) argue that changes in the US regulatory structure during the 1980s increased the liquidity in financial markets and made it easier for US banks to raise wholesale funds, making the supply of loanable funds to banks more elastic. In the United Kingdom, the share of wholesale deposits in M4 has increased from an average of around 20% between 1983-85 – the pre "Big Bang" period – to around 30%, over the last three years; consistent with the notion that wholesale funding has become easier for banks.

Firm level studies have tended either to estimate cross-sectional investment equations directly, and test whether financial factors have a role in explaining the investment behaviour of constrained firms, or to estimate first order conditions for investment – Euler equations – and test whether these are violated for constrained firms. A common strategy amongst the papers that directly model investment has been to assess whether specification failures in Tobin's q can be explained by financial variables. The rationale comes from Hayashi (1982), who showed that Tobin's q will provide the optimal investment rule for firms only if capital markets are perfect, and if there are (known) installation costs associated with investment.

One of the first studies was by Fazzari, Hubbard and Peterson (FHP) in 1988. They found that financial structure variables play an important role in explaining investment behaviour across different classes of publicly quoted manufacturing firms in the United States. They divided their sample of firms into three categories, according to their dividend payout ratios. Those firms who pay the least dividends are likely to have exhausted available internal funds, and so have to rely on external funds to finance investment (Myers and Majluf (1984)). By contrast, firms which pay high dividends are likely to have sufficient internal funds to finance investment, or do not have to pay a significant external finance premium – perhaps because they are well know firms operating in mature industries. If capital market imperfections are unimportant then, as discussed above, variations in Tobin's q should be able to account for firms' investment. Consistent with this notion, FHP found that the investment behaviour of the high dividend payers could be adequately explained by Tobin's q ratio, but that financial factors (cash flow) were an important additional determinant of investment for the lowest dividend payout class of firms.[14] Many subsequent studies using different proxies for financial factors have reached similar conclusions (Gertler and Hubbard (1988), Whited (1992), and Hoshi, Kashyap and Scharfstein (1991)).

Studies of US firms that adopt the Euler equation approach generally reach similar conclusions. For example, Hubbard and Whited (1995) find that the over-identifying restrictions for the Euler equation are rejected for financially constrained firms (those that pay low dividends) but are not rejected for financially unconstrained firms. Cross-sectional evidence in the United Kingdom is slightly less compelling. For example, Bond and Meghir (1994) estimate Euler equations for constrained and unconstrained firms. While they find that financial factors are unimportant for unconstrained firms – consistent with the theory – they find that the violation of the Euler equation is wrongly signed for constrained firms, in the sense that increases in cash flow are correlated with falls in investment.

More recent work at the Bank of England (Small (1997)) analyses whether cash flow has a significant positive effect upon inventory investment. The study analyses the investment behaviour of 605 UK-quoted firms over 1977-94 whose prime business activity was manufacturing. Inventory investment is modelled as a function of the lagged stock of inventories, current and lagged sales and a cashflow term.[15] The importance of cash flow is then investigated, with the firms divided into constrained and unconstrained groups according to four characteristics: dividend behaviour, interest cover, firm size and the current ratio.[16]

The study finds that firms' current cash flow has a significant positive effect upon inventory investment. However cash flow appears to matter for both constrained and *un*constrained

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[14] One objection to this type of study is that measures of Tobin's q - average q - may actually be a very noisy measure of the true shadow value of marginal capital expenditure, so that tests for incremental explanatory power from financial variables is weak. As Hayashi (1982) also demonstrated average q will only always equal the economically important marginal q when firms are price takers, and have technology which exhibits constant returns to scale.

[15] As in common in panel data analysis, firm and specific effects are also allowed for.

[16] Interest cover is defined as the ratio of interest payments to operating profits and the current ratio as the ratio of current assets to current liabilities.

firms (under each criteria). This finding is puzzling as it suggests financial structure matters even when there are no financial constraints. Some more limited support for the credit view is provided, however, in that the size of the cash flow effect upon investment seems to be greater for constrained firms than unconstrained firms, and the difference appears statistically significant.

An alternative – but complementary – time series approach was adopted by Gertler and Gilchrist (1994). They investigated the sensitivity of output and inventory investment by manufacturing firms to monetary shocks through time. They split their sample into "small" and "large" firm sub-samples, and found a greater sensitivity in the behaviour of small firms, even after controlling for the variation in firms' sales. This provides indirect evidence of an external finance premium leading to differential monetary policy effects across differing classes of firm.

Similar analysis has been carried out at the Bank (Ganley and Salmon (1997)). This work has focused on the disaggregated effects of monetary policy shocks on the output of 24 sectors of the UK economy. The principal aim of the analysis was to provide stylised facts about the sectoral responses to unexpected changes in monetary policy. However, it also provided indirect evidence about the underlying nature of the transmission mechanism by suggesting that the effects of unanticipated monetary policy tightenings are unevenly distributed across sectors of the UK economy. As might be expected, sectors such as construction show a sizeable and rapid decline in output, whereas others, like services, show a much more muted reaction. Manufacturing as a whole also responds quite sharply to a monetary tightening, but some large industrial sectors, notably utilities, show a subdued reaction. Moreover, the 14 sub-sectors that comprise manufacturing also exhibit diverse responses to a monetary shock. The paper shows that the pattern of these sectoral manufacturing responses seems correlated with the size characteristics of the firms in each sector.[17] In particular, sectors which mainly comprise "small" firms tend to exhibit a stronger reaction to monetary shocks than sectors that mainly comprise "larger" firms. This result is consistent with a "credit view" of the transmission mechanism, in as much as the small manufacturing firms experience greater variation in their external finance premium. But of course, other factors could lie behind this pattern.

4. Extracting information from equities

The evidence presented in the last section suggests that equities may have a structural, as well as leading indicator, relationship with firms' investment. Further, it suggests that the importance of financial factors upon firms' activity is clearly going to vary across types of firm, and the state of the business cycle.

The difficulty is that concluding that equities may have structural importance is not akin to identifying a structural model that can be estimated to test this hypothesis. The credit view of the transmission mechanism in particular does not offer a unified alternative to traditional views of the transmission mechanism. Rather, it just suggests ways in which the traditional view may be deficient.

From a modelling perspective this points to an atheoretic approach. This can, at the very least, help answer the most basic question as to whether equities contain leading information for the rest of the economy, regardless of whether this derives from structural relationships.

This section presents the results from some preliminary VAR work that is in the spirit of this approach, and then discusses how it might be extended.

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[17] Because of the historic importance of manufacturing in the United Kingdom, more detailed data are available for this sector than for the rest of the economy, even though its aggregate importance has declined. Hence, it was possible to carry out the "size characteristics" analysis for only the manufacturing sector.

Following work in the United States by Lee (1992) we have estimated a small (non-structural) VAR model with four variables: real equity returns, real interest rates, growth in industrial production, and inflation. The "causal" ordering used in the VAR model is as follows: real equity returns, real interest rates, growth in industrial production and inflation. The only deterministic component in the VAR model was a constant, and we used six lags of the variables on monthly data from April 1988 to December 1994. The real interest rate was the return on the Treasury bills less the inflation rate, computed as the monthly change in the Retail Price Index. Real equity returns were computed as the monthly return on the value-weighted FT-All Share Index less the inflation rate. Real activity in the economy was proxied by the growth in industrial production.

The results from this simple VAR model are provided in Table 2. The main points to note are:

1) Real equity returns do not appear to be exogenous, in the sense that after 24 months over 30% of their variation is explained by the three other variables in the system. Of the other variables the real interest rate is the most important, consistent with the notion that monetary shocks have a significant influence on equity prices.

2) Equities do appear to have some incremental information in terms of forecasting real activity. After 24 months equities account for 8.6% of the forecast error variance in real activity, compared with 12.4% for real interest rates.

3) After 24 months, only about 7% of the variation in inflation can be attributed to real equity returns, while innovations in real interest rates explain almost 30% of the variation in inflation.

3) After 24 months, almost 67% of the variation in real interest rates is explained by innovations in inflation.[18] After a similar period, real equity returns only account for 14% of the variation in real interest rates.

Table 2

Simple VAR model results (in percentages)

	By innovations in:			
	Real equity returns	**Real interest rate**	**Industrial production growth**	**Inflation**
Variable explained (after 24 months):				
Real equity returns	69.9	18.6	4.6	6.9
Real interest rate	14.4	8.6	10.6	66.1
Industrial production growth	8.6	12.4	69.8	9.3
Inflation	6.6	29.4	12.2	51.8

Note: Due to rounding errors, the rows may not add to 100%.

Lee (1992) obtains similar results. In particular, US real equity returns also appear to have some Granger causal information for real activity, as measured by growth in industrial production. Roughly 11% of the variance in real activity can be ascribed to real equity returns. Impulse response analysis shows that the response of real activity to shocks in real returns is strong

[18] A complication of interpreting this result arises because we have used a backward-looking measure of real interest rates by using inflation outturns.

and positive for the first 12 months, after which it tapers off. US equities appear to have even less information for inflation than UK equities.

The results for the United Kingdom are very preliminary; no attempt has been made to gauge the robustness of the reported results to the choice of lag length or alternative causal ordering in the VAR model. In addition, the analysis does not use a particularly long span of data, and considers only one data frequency, monthly. But, more fundamentally, we intend to extend the form of the VAR in a number of ways.

(i) Disaggregation

Disaggregated analysis has clear potential to isolate clearer, and distinct links between equities and activity. We propose to construct equity returns for industry sectors (either equally weighted or value weighted) which would reflect the general trend of share price movements in the specific sector. This could then be combined with more disaggregated macroeconomic data, in order to construct a range of sectoral VARs. Another aspect of the disaggregated analysis would be to consider the contribution of various sectors to the aggregate growth outlook implied by the equity market. This would provide an indication of the degree to which growth is likely to be balanced or concentrated in, say, exports, as in the early stages of the most recent recovery.

(ii) Sub-period analysis

One implication of Section 1 is that the external finance premium, and possibly the importance of equity price changes, will vary with the state of the cycle and monetary policy. Sub-period analysis (as in Titman and Warga (1989)) would help establish whether this is the case. In terms of monetary policy, estimation over distinct sub-periods (for example, post ERM) might be more appropriate.

Separately, there is the question of the forecast horizon, i.e. how many periods ahead would we expect current equity returns to forecast real activity? In theory, movements in equity returns reflect agents' expectations over an infinite time horizon. But, in practice, the time horizon will be shorter as a result of the effects of discounting and, possibly, the short-termist nature of the equity market.

(iii) Expectations extraction

A complementary approach to examining the information content of equity prices would be to extract expectations of future dividends and discount rates contained in equity prices, and then consider how these relate to future real activity. This approach may be preferable for a number of reasons. First, it is likely that, in practice, equity returns will turn out to be a noisy indicator of future macroeconomic activity. By considering the expectation variables directly, it may be possible to remove (or reduce) noise, and hence avoid this problem. Second, this approach would also have the advantage that it would be possible to ascertain the relative importance of expectations of dividend growth and discount rate changes for predicting real activity.

For our purposes, the first step would be to use the VAR model employed by Campbell and Shiller (1989), Campbell and Ammer (1993) and Paisley (1995) to generate expectations of future dividends and discount rates. The second step would then involve using these expectations variables, instead of (raw) equity returns data, in our original VAR model to consider the leading indicator properties of these variables. Note, however, that these expectations variables would still contain some noise.

5. Information from options

In this section we focus on traded options on the FTSE 100 Index to obtain ex-ante information about future market moves, which in turn might have implications for consumption and investment behaviour.

Option markets provide a richer source of information than is available from the futures market. Unlike futures markets, which only provide information about the expected future *level* of the market, implied PDFs derived from the options market tell us what probability agents attach to all possible values of the index at some terminal date. Consequently, by focusing on the information embedded in implied PDFs, monetary authorities can reach a more comprehensive assessment of overall market sentiment.

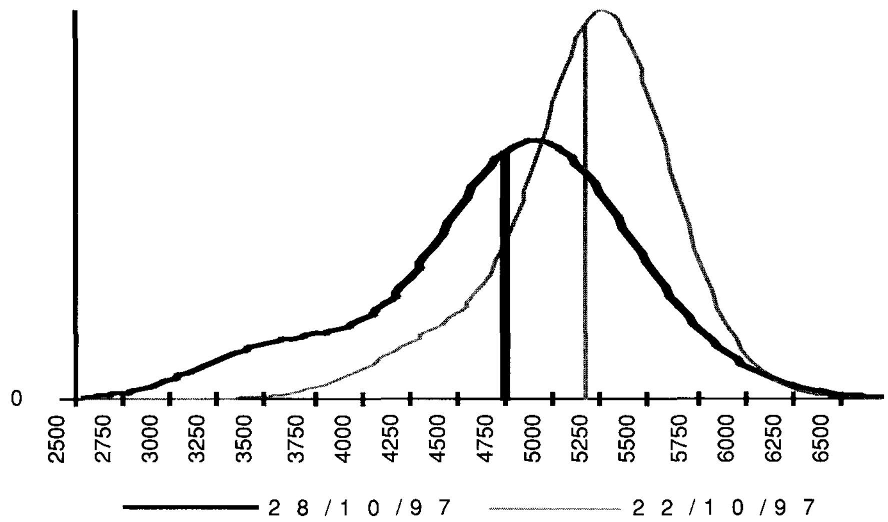
However, before looking at changes in the PDFs around specific events, it may be instructive to outline the method used in the Bank to extract them. Briefly, an option price is assumed to be equal to the present value of the discounted probability-weighted future payoffs to the option. What we are interested in is finding out the probabilities attached to each possible payoff at the maturity of the option. We use a non-linear optimisation routine (Powell) to minimise the squared difference between observed and theoretical option prices to recover the set of probabilities consistent with the observed option prices. To obtain these probabilities we need to assume a particular distribution for the underlying instrument at option maturity. It is well known that asset price distributions are not log normal, but that they are close to log normal. A distribution that is close to, but not exactly, a log normal distribution can be closely approximated by a linear combination of two log normal distributions – a mixture distribution. Our optimisation technique recovers the mean and the variance of the two log normal distributions, and the relative weights attached to the two distributions. The overall shape of the mixture implied distribution is entirely determined by 5 parameters. Bahra (1997) contains a detailed technical description of the technique used in the Bank.

It is worth bearing in mind that the PDFs extracted from option prices are risk-neutral, rather than the market's subjective distribution of expectations. This is because options are priced using a risk-neutral distribution. Rubinstein (1994) shows how one can link the risk-neutral and the subjective distributions for a "representative" risk-averse investor. Some preliminary work along the lines suggested by Rubinstein has been conducted in the Bank and the upshot of the research is encouraging: the risk-neutral and subjective FTSE 100 implied distributions are qualitatively similar.

Chart 4

FTSE 100 PDF, December 1997 contract

Probability density (% probability per 10 b.p.)



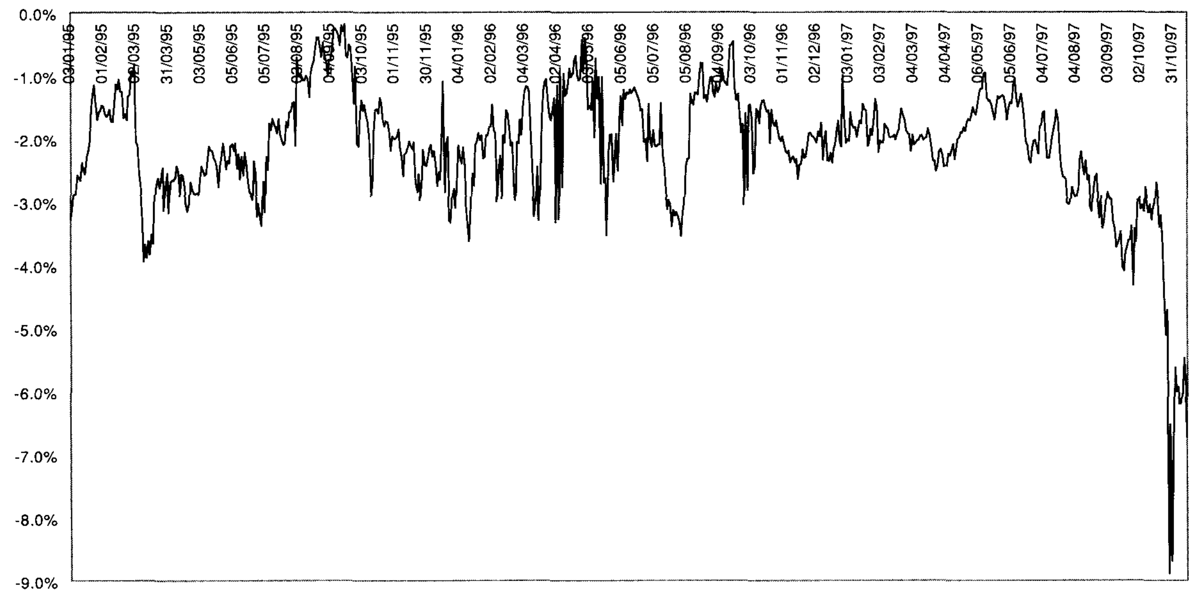
To illustrate the usefulness of this technique in providing information about market sentiment which is not adequately revealed in the level of the index, we focus on a specific event in October of this year. Chart 4 shows the implied risk-neutral FTSE 100 PDFs on 22nd and 28th October for the December contract. The turbulence in the Hong Kong market spilled over into other world equity markets on 23rd October. It is immediately apparent that there is more probability mass in the left-hand tail of the distributions, implying negative skewness. Intuitively, this means that the market attaches a higher probability to further large falls relative to large rises. This negative skew is a common feature of the UK equity options market and has existed since 1990.[19] Moreover, it is clear from Chart 4 that the negative skewness became much more pronounced after the sharp fall in the FTSE 100 between the two dates. This large increase in negative skew was also apparent in the March and June 1998 contracts.

What implication does the negatively skewed implied FTSE 100 distribution have for monetary policy? One possibility is that monetary authorities should be less concerned about the possible wealth effects on consumption of a rise in the stock market. This is because, to the extent that the strong negative skew in the implied distribution reflects the fact that agents are attaching a large probability to a significant market correction, the impact of wealth effects on consumption is likely to be somewhat subdued.

To gain a longer term perspective on how agents' expectations about the future level of the FTSE index has changed, we look at the time series of skewness of the implied PDFs. At this point it is worth pointing out that the time series of moments that we recover from the implied PDFs cannot be compared from one day to the next (or over longer measurement intervals). This is because option contracts have a fixed time to maturity, and so, as the option contract nears maturity, agents' uncertainty about the price of the underlying asset on which the option is written tends to decline. In other words, the time-series of implied moments exhibit a time trend. The presence of a time trend in the implied moment makes it difficult to ascertain the extent to which day-to-day changes in the implied statistic are due to news, or simply a consequence of the fact that the option is closer to maturity. In the analysis that follows, we strip out the effect of declining time to maturity from the implied statistic.

Chart 5

Skew in FTSE 100 PDF



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[19] The US market is also characterised by negative skewness and, if anything, the negative skewness in the US market is even more pronounced and has existed since the 1987 crash.

Chart 5 shows how adjusted skewness in the FTSE 100 PDF has evolved since 1995. Although the skew has been negative for the whole period, the turbulence in October caused a dramatic increase in negative skew from around -3% to around -7%.

The message from the PDFs is that the market has been consistently pricing in the possibility of a correction. There is some indication that the market thinks that the likelihood of such a correction has increased over the year, particularly since the turbulence in Asian and Latin American equity markets. It seems plausible that the impact of wealth effects on consumption may be lower than if the market were at the same level, but with a more symmetric distribution.

Summary

In this paper we discuss techniques that enable us to extract information about the equity risk premium and dividend growth expectations from the market. From a policy perspective, the equity risk premium is of interest because it is an important component of the cost of capital which, in turn, is an important determinant of investment expenditure in the economy. Besides, changes in the risk premium have implications for the level of the market. Dividend growth expectations are closely correlated with profit expectations; therefore, by focusing on the former, monetary authorities may be better able to assess inflationary pressures in the economy.

We have looked at the role of equities in the transmission mechanism. Both the traditional and "credit" views of the transmission mechanism are discussed. In particular, we review the theory and empirical evidence which suggests that equity price movements may have a causal impact on the corporate sector.

With regards to extracting information from equity markets, some preliminary work with a VAR model suggests that equities may contain information about the real economy. It is likely that the components of returns, such as expectations of future dividends and discount rates, may prove more useful leading indicators, but much work remains to be done before we can be more certain.

Option markets enable us to extract the probability agents attach to all possible levels of the market at some terminal date and so allow a more comprehensive assessment of market sentiment. More work needs to be done to see whether the moments of the implied distribution, such as skewness, can predict future market moves and whether they are significant determinants of consumption and investment behaviour. At the Bank we are currently investigating these issues.

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