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The Value Relevance of Sentiment

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Abstract

It is generally accepted that excessive exuberance or gloom in investor sentiment contributes to booms and crashes in share prices. However, views differ on the merits of active policy intervention due to gaps in our understanding of the transmission mechanism. To fill this gap we apply a fully ex ante valuation model in which an index of investor sentiment is included along with earnings and growth fundamentals to explain value. The outcome is a precise indication of the value relevance of sentiment. We employ the investor sentiment indicator proposed by Baker and Wurgler (2007). Valuation, and implied permanent growth, based on the inclusion of standard fundamentals is compared with that obtained when sentiment is added. The resulting ratio produces an index of 'the valuation effects of sentiment' that can be assessed with statistical significance. Out-of-sample fit is also examined. For the Dow index the valuation effects of sentiment are significant and as large as 40% of market value at the peak of the 'dot-com' bubble. The index we propose identifies conditions, detectable in advance and under the control of policy makers, that are conducive to the creation of asset bubbles. It is easy to construct, timely, robust and can be used improve our understanding of what leads to bubbles and crashes and to inform policy.

JEL classification: E32, E44, E58, E66, G10, G12, G14.

Keywords: Bubbles, fundamental valuation, sentiment, early warning indicators.

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Non Technical Summary

Investor sentiment, rather than real 'value-enhancing' earnings performance, is often thought to drive the value of the equity market. While there is a lot of evidence for excess volatility of returns (or excess price-earnings ratios) that cannot be explained by variation in fundamentals, an agreed-upon methodology for quantifying the actual contribution of investor sentiment to value is not yet available. Sentiment movements do not always result in proportionate market movements and the transmission mechanism involves complex interactions between sentiment and other variables used in the valuation exercise. This poses a problem for policy makers concerned with identifying the existence, magnitude and causes of 'bubbles'. We apply an ex ante approach to fundamental valuation of stock market equity that controls for non-linear and interactive sentiment effects. A novel aspect of our approach is the use of forecasts of macroeconomic variables and other ex ante measures that are not usually used in such valuations. These include option-implied 'betas' and forecasts of the macroeconomic drivers of earnings growth taken from the Survey of Professional Forecasters compiled by the Federal Reserve Bank of Philadelphia. We find that sentiment is often responsible for a significant proportion of market valuation (in the region of 40% during the 'dot-com' bubble). The bubble effects are distributed unevenly across sectors with finance and technology stocks being more prone to such effects. Our measure of market dislocation can be used to inform macro-prudential policy aimed at avoiding the effects of excessive exuberance or gloom. It can also be related to other market psychology indicators and policy variables with the objective of gaining a better understanding of the causes of asset bubbles and crashes.

1 Introduction

The idea that investor sentiment is part of what drives stock markets is a well established theme. Shiller (2005) is just one example of a vast literature that provides evidence of the probable presence of such effects. As yet however, a timely and generally accepted indicator of the valuation consequences of these effects remains elusive. Furthermore, we find that the transmission of sentiment to valuation involves non-linear interactions with other variables in the valuation process so that sentiment indicators alone are insufficient to warn of the potentially harmful effects of investor exuberance or gloom. Using *ex ante* estimates of valuation fundamentals our analysis gives rise to an indicator of the valuation effects of investor sentiment. We apply simple nonlinear regression analysis that incorporates sufficient constraints to ensure a robust representation of the valuation relationship given the available information at each date. Our analysis indicates the importance of assessing sentiment effects in relation to the divergence between the cost of equity capital and the expected long-term growth in earnings. It also identifies periods in which conditions are conducive to bubbles arising from sentiment shocks. These conditions can be detected in advance and are largely under the control of policy makers.

Following the recent financial crisis there has been renewed interest in the debate as to whether monetary policy should be used to prick asset, and real estate, price bubbles.[1] After the peak of the crisis fears abounded that bubbles were developing in commodities markets and in emerging economies as a direct result of the prolonged low interest rate and quantitative easing policies conducted in crisis-hit economies. At his confirmation hearing in the fall of 2009 the Chairman of the US Federal Reserve, Ben Bernanke described this as "the most difficult problem for monetary policy this decade."[2] Thus, while policy makers are often fearful of such occurrences they are seldom able to quantify their magnitude and this has implications for how confidently they can proceed in redressing the situation. The pre-crisis view about bubbles is associated with Bernanke and Gertler (2001) where a passive policy stance is advocated largely motivated by the view that bubbles are hard to detect and that any monetary policy reaction could magnify their dynamics. Recently, however, there is less unanimity about the presumed difficulty of identifying bubbles. The president of the New

[1] See "Fed Debates New Role: Bubble Fighter", by John Hilsenrath, Wall Street Journal, December 2, 2009 page A1.

[2] More formal examination of the pre-crisis period by Adrian and Shin (2009) found that borrowing in the repo market was a probable cause of the housing and credit bubble.

York Federal Reserve recently stated that "bubbles may not be that hard to identify – especially large ones."[3] He also stated in the same speech... "I agree that the instrument of short term interest rates is not well-suited to deal with asset bubbles….this suggests that it might be better for central bankers to examine the efficacy of other instruments in their toolbox, rather than simply ignoring the development of asset bubbles." This growing but cautiously positive stance towards policy activism (of whatever type) in respect of asset price bubbles greatly depends on how quickly and accurately such bubbles can be identified and measured.

The purpose of this paper is to show that equity market valuations can indeed be attributed to a combination of fundamentals and sentiment-related exuberance or gloom represented by well-known and reliable indices of investor sentiment. But this effect should be viewed in the context of its non-linear relation with other macroeconomic inputs to the valuation process. Once a non-linear valuation metric is adopted there is a higher chance of errors in out-of-sample forecasting but when these errors are properly interpreted they are very informative regarding the potential effects of sentiment. This is particularly true when the required rate of return on equity and expected long-term growth rates are similar in magnitude. In these circumstances sentiment changes can begin to dominate the valuation process. Thus, by applying a well understood valuation metric and using few steps or estimation constraints, we identify valuation effects that can be robustly attributed to sentiment. Our approach contributes to the extant literature that seeks to measure the role of earnings or dividend fundamentals such as Campbell and Shiller (1988a & 1988b) or that explain returns rather than valuation levels as a function of sentiment, such as Baker and Wurgler (2007). However, previous studies typically avoid the step of capitalizing dividends or earnings and focus on excessive price-to-earnings or dividend ratios as evidence for exuberance and sentiment effects. These studies therefore side-step important non-linear effects that reduce the precision of estimated results. Our contribution is to introduce *ex ante* variables fundamental to equity valuation to improve and simplify the capitalization of earnings so that intrinsic value and price can be directly compared. We also proceed to examine the returns relation as an *error correction process* rather than as an *asset pricing* relation. If returns can be regarded as reversing market inefficiencies on average over time then it is appropriate to improve

[3] Remarks by William C. Dudley entitled "Lessons Learned from the Financial Crisis," delivered at 8th Annual BIS Conference, Basel, Switzerland. http://www.newyorkfed.org/newsevents/speeches/2009/dud090702.html

prediction of returns using our best estimates of such inefficiencies and this is precisely what an *error correction representation* achieves (see, Engle and Granger 1987).

Our analysis extends previous attempts to uncover sentiment effects by using selected *ex ante* inputs more flexibly than previously. In terms of our results we add to previous work by deriving two approaches to examining the valuation implication of sentiment. We find this is necessary because the effects of sentiment are obscured if just one of the available viewpoints is considered. The first viewpoint is based on a direct examination of the differences in the 'with' and 'without' sentiment valuations. The second viewpoint is obtained by testing the significance of the difference in implied growth rates of earnings derived from the valuation exercise with and without sentiment effects. Variation in risk aversion is a plausible alternative avenue through which sentiment has its effects. However, we prefer to attribute these to implied growth rather than risk aversion which is simply an identifying restriction that has little significance for our conclusion that sentiment effects are an identifiable component of valuation.

As far as is practically possible, we use an *ex ante* valuation approach. Given the forecasts of future earnings, three important unknowns remain in the valuation exercise. These include (i) risk premia associated with various risk factors, (ii) stock-specific sensitivities to such factors and (iii), predictions of the long-run growth prospects for earnings. We use a single risk factor and we make use of option-implied measures of stock-specific betas to expose an *ex ante* market risk premium. The forward-looking betas from the analysis of Christoffersen, Jacobs and Vainberg (2008) are used as an input.[4] We test for the relevance of the Fama-French and momentum factors in our analysis, but we do not find significant effects.[5] The complexity introduced by multiple risk factors and the error associated with their exclusion does not appear to be as detrimental for valuation accuracy as omitting sentiment effects.[6]

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[4] This approach is supported by findings that stocks immune to sentiment are likely to possess option-implied betas that are a reliable reflection of *ex-ante* betas (Lemmon and Ni, 2008).

[5] There is little consensus on how many factors are needed to correctly price the risks associated with specific equity investments. Numerous asset pricing alternatives exist, such as the Arbitrage Pricing Theory model, the Fama-French (1993) three factor model, the models outlined in Haugen and Baker (1996, 2009) and Campbell and Vuoltenaho's (2004) Good-Beta/Bad-Beta model. With additional risk factors and unknown *ex ante* sensitivities to these factors valuation is impossible without a number of restrictions that can always be contested. At a very basic level it is arguably the case that factors based on *ex post* portfolio returns are invalid in an *ex ante* context.

[6] Some of these issues are addressed by the 'behavioural finance' literature. For example, Benartzi and Thaler (1995) use the "narrow framing" argument to explain overestimates of the risk premium by investors. See also, Hirshleifer 2001, Brunnermeier 2001, Shiller 2005 and Epstein & Schneider 2008.

Indeed, Buss, Schlag and Vilkov (2009) show that a simple CAPM can be defended when sentiment effects are either absent or controlled for.[7] Recent studies by Kumar, Srescu, Boehme and Danielsen (2008) and Adrian and Franzoni (2009) demonstrate that once the estimation risk associated with beta and the risk premium are accounted for, the conditional CAPM has significant explanatory power in the cross-section of stock returns.

We estimate long-run earnings growth as an implicit non-linear function of investor sentiment and economic growth. We restrict the implied long term growth rate to be non-negative, but otherwise it is permitted to be a flexible functional form involving sentiment and other drivers of growth including forecasts of long-term real GDP growth expectations. These expectations are obtained from the Survey of Professional Forecasters (SPF) compiled by the Philadelphia Federal Reserve. The use of this growth relation helps to mitigate the distorting effects of optimistic analyst forecasts (Abarbanell and Lehavy, 2003; Easton and Sommers, 2007, Ciciretti et al. 2009).[8] Our approach therefore has a macroeconomic focus and in this respect, it has a correspondence with the asset price bubbles literature that uses macroeconomic fundamentals to identify market misalignments such as Bordo & Jeanne (2002), Detken and Smets (2004), Machado & Sousa (2006), Alessi and Detken (2009), Agnello and Sckucknecht (2009) and Gerdesmeier, Reimers and Roffia (2009). Macroeconomic growth is generally slow moving (is related to expected future policy stances by monetary authorities) and used in combination with the near term I/B/E/S (hereafter IBES) forecasts of earnings reduce some of the excessive variation in asset-specific valuations associated with analysts' long term forecasts.[9]

Since, the discounting process can introduce error we minimize this by using interest rate projections from the SPF in our discounting formulae. This overcomes a serious difficulty associated with the use of short term interest rates to represent the risk free rate in such models. Treasury Bill rates are often quite far from their expected long-run equilibrium and when they are used in capitalization formulae such as the Gordon growth model, they can easily give rise to a negative denominator (i.e., a low risk free rate 'r' and a high growth rate

[7] Buss *et al* find that there no role for firm characteristics such as size and book-to-market in a low sentiment regime. This finding is also supported by Chung & Yeh (2009).

[8]While there may be incentives for analysts to exaggerate equity-specific earnings growth it is difficult to think of reasons why macroeconomic growth forecasts would contain similar biases.

[9] Sharpe (2002) has shown that forecasts of longer term earning growth possess the largest part of the bias in analysts' forecasts. I/B/E/S stands for Institutional Brokers' Estimate System which is currently owned by Thomson Reuters.

‘g’ will produce a negative or extremely small, r-g). We find that use of the long run forecast of the Treasury Bill yield from the Survey of Professional Forecasters avoids this problem. More importantly, by including long term expected risk free rates we are accounting for the agents’ expectations of future monetary policy decisions. Thus we obtain plausible results for all of the Dow Jones 30 equities examined for all of the time periods in our sample. This reliability characteristic is an attractive feature rendering this method of practical benefit as an indicator of excessive sentiment effects.

Two important findings are worthy of mention. Firstly, we find that the valuation effects due to sentiment are quite pervasive. For the majority of firms in our sample it is difficult to reject the hypothesis that sentiment accounts for a significant proportion of value. We find that ‘with’ sentiment valuations can be almost double valuations based on traditional fundamentals. Our sample period includes the dot-com bubble and this period is very accurately captured by the gap between price and fundamental valuation and much of this gap can be attributed to sentiment effects. Our findings support the view that bubbles can be identified and it therefore generates increased scope for arbitrage that could improve market efficiency. The proposed indicator of the value relevance of sentiment can be used by policy makers to accurately identify, at an early stage and with statistical confidence, the presence of asset price misalignments and consider policy reactions to counteract their effects. The production of a more accurate and timely measure of the valuation effects of investor sentiment is, in our view, a pre-requisite for an important debate about the role of sentiment in asset bubbles and how these effects can be mollified by policy initiatives.

The remainder of the paper is organized as follows. Section 2 outlines our valuation approach and our econometric methodology. Section 3 discusses data used in the application and Section 4 presents the main results with discussions about the likelihood of sentiment being a large contributor to valuations. Section 5 concludes.

2 An Old Valuation Metric with New Clothes

To achieve a best fit for market prices given our earnings and macroeconomic information set we model fundamental value in the context of a modified Gordon Growth model that includes various *ex ante* inputs omitted in previous studies. The model is applied to earnings rather than dividends.[10] We use consensus IBES 'core earnings' forecasts as the 'above-the-line' drivers of fundamental valuation and stock-specific sensitivity to forecasts of long-term economic growth from the SPF as 'below-the-line' drivers. While we use a baseline valuation derived with inputs that are familiar in the extant literature, we also extend the valuation metric to include other variables. We use the VIX index as an *ex ante* proxy for the amount of systematic equity risk.[11] The SPF provides long-run projections for real GDP growth and the risk free interest rate and we use *ex-ante* option implied betas from Christoffersen *et al.* (2008). Thus, our approach makes use of a number of *ex ante* that, to our knowledge, surpasses what is done in the extant literature. We proceed to outline our fundamental valuation metric firstly without and then including the effect of sentiment.

For simplicity, the Gordon Growth model (Gordon, 1962) is applied to earnings from any specific equity as follows;

$$\mathrm{P}_t = \frac{\mathrm{e}_t}{r^e - g} + \eta_t$$

Where, P_t is the market price per share for a given equity, e_t is core earnings per share, r^e is the cost of equity capital for the specific equity concerned, and g is considered to be the permanent real growth rate expected to apply to core earnings for the foreseeable future. We assume that any pattern for future growth projections can be approximated in this way. The use of the nominal interest rate in discounting should account for the effects of inflation expectations on earnings projections such that it would be appropriate for g to be the expected **real** rate of growth in earnings. However if there is 'money illusion' it may be necessary to include inflation expectations separately to account for this inefficiency. Also, expected inflation may in fact have a role in predicting future real growth since high expected inflation is usually associated with expected future contractionary macroeconomic policies. We allow for this by including inflation expectations from the SPF in the more general specifications

[10] Fama & French 2001, describe how the proportion of firms in the US that make dividend payments fell from 66% in 1978 to only 20.8% in 1999. This makes fundamental analysis based on dividends impractical for a large proportion of the market. There is a large literature on dividend irrelevance begun by Modigliani & Miller (1961) and extended by Miller and Rock (1985) relating the dividend decision to one of signalling an absence of 'over-investment'. Our view is uncertainty as to whether earnings are optimally distributed or reinvested is part of systematic risk and therefore mostly captured in stock-specific betas and in the implied risk premium. We also regard the estimated growth rate of earnings as capable of reflecting differential earnings retention policies.

[11] Whaley (2008) provides an account of how the VIX index is related to stock prices. Typically, the relationship is inverse but during prolonged 'bull' markets there is a positive relationship in the run up to market 'corrections'. We include the VIX in the discounting of the near-term earnings only and we assume that the long-run historical average of the VIX can be used for discounting the 10 year ahead projected earnings.

described below. The error term η_t includes all other drivers of value not captured by the simple model. These are omitted in the model extensions outlined below).

The basic model above can easily be expanded to produce a more deconstructed model. For example, we can let the required return on equity be determined as follows;

$$r_t^e = \boldsymbol{r}_t^f + \beta \ market\ risk\ premium$$

Where $\boldsymbol{r}_t^f$ is the risk free rate of return (specifically the SPF expectations of future Treasury bill rates) and β is the aforementioned 'forward-looking' option-implied stock-specific sensitivity to market-wide risk proposed by Christoffersen et al (2008). To indicate the presence of a time varying beta we add a time subscript in future notation. We derive fundamental valuation under the assumption of a constant level of risk aversion and a variable amount of systematic risk. More specifically, we assume that the risk premium can be split into (i) an amount of expected future systematic risk represented by the VIX index and (ii) the price of risk in terms of excess return required by the average investor for exposure to such risk. This gives rise to the following required return expression (where Q denotes the 'price of risk' and VIX represents the expected amount of market risk);

$$r_t^e = \boldsymbol{r}_t^f + \beta_t \ Q \ VIX_t$$

We initially estimate Q as a constant, thus, the squared error of the price-value relation is minimized over the entire sample).

The long run-growth rate of earnings, g, is assumed to be a function of expectations of long run macroeconomic growth and inflation (SPF ten year ahead forecasts of average annual real GDP growth and ten year ahead forecasts of average annual CPI inflation). This is;

$$g_t = \ (\alpha_0 + \alpha_1 \ \mathrm{RGDP10}_t + \alpha_2 \ \mathrm{CPI10}_t)^2$$

We restrict the estimated growth term to be positive by estimating the relation with the growth 'sub-equation' squared. This implies that there are interactions (multiplicative cross-terms) between the various variables and constants in the growth equation.

We use a further modification of the Gordon growth formula so that permanent growth applies only after period 2. This takes account of the fact that we have IBES earnings forecasts in respect of Fiscal Year 1 (FY1) and Fiscal Year 2 (FY2). The basic valuation equation is as follows:[12]

$$\mathrm{P}_t = \hat{V}_t = \frac{\mathrm{FY1}_t}{\left(1 + \boldsymbol{r}_t^f + \boldsymbol{Q}\beta_t \mathrm{VIX}_t\right)^a} + \frac{\mathrm{FY2}_t}{\left(1 + \boldsymbol{r}_t^f + \boldsymbol{Q}\beta_t \mathrm{VIX}_t\right)^b \left(\bar{\boldsymbol{r}}_t^f + Q\bar{\beta}\overline{\mathrm{VIX}} - (\alpha_0 + \boldsymbol{\alpha_1}\ \mathrm{RGDP10}_t + \boldsymbol{\alpha_2}\ \mathrm{CPI10}_t)^2\right)} \quad (1)$$

Where:

P_t= Market price per share for a specific equity at time t,

$\hat{V}_t$= fitted fundamental value per share for a specific equity at time t,

$FY1_t$ = *IBES* current fiscal year 'core' earnings per share forecasts (where the most recent or next annual earnings are forecasted each month),

$FY2_t$ = *IBES* next fiscal year (or two year ahead) 'core' earnings per share forecasts (annual),

r_t^f = Survey of Professional Forecasters' 3 month T-bill rate for the current year,

$\bar{r}_t^f$ = Survey of Professional Forecasters' 3 month T-bill rate (expected 10 year average),

β_t= an *ex ante*, option-implied, stock-specific, time-varying beta,

VIX_t= the *VIX*/10 represents the *ex ante,* amount of market risk implied by S&P500 one-month ahead options. We assume that investors expect the VIX to return to its long run average in the very long term and this enters the last term in the denominator. The long run value for this $\overline{VIX}$ is set equal to its historical median = 1.888 as described by Whaley (2008),

$RGDP10_t$= Real GDP long-term growth expected. This is based on the SPF forecast of 10 year average real GDP growth,

$CPI10_t$= long-term growth in prices expected. This is based on the SPF forecast of 10 year average inflation expectations,

$\alpha_{0,1,2}$ = parameters describing the equity-specific growth level expected on average over the whole sample and the implicit relation between variation in firm-level long-term growth in earnings and expected 10 year Real GDP growth and CPI inflation,

Q = a number to be solved-out that will represent the equilibrium price of systematic risk,

a and b are the appropriate exponents for discounting *FY1* and *FY2* respectively, the required number of months from the forecast date to the date of recognizing the earnings in annual accounts (we divide the required rate of return by 12 so that it applies to monthly time value adjustments, not shown in the formula for clarity in the exposition.

[12] We take natural logs of both sides when estimating the relation and assume an additive regression error which implies a random proportional error between price and value if the error is small enough that ln(1+error) ≈ error.

The main missing variables in equation (1) include additional risk factors and a role for sentiment effects. Our preference is to exclude other risk factors since they are not available to investors in an *ex ante* sense. However, to support this stance we statistically test whether the exclusion of Fama-French and momentum factors significantly reduces the goodness of fit when the following more general model is estimated (where, as usual, SMB means *small minus big*, HML means *high minus low* and MOM means *momentum*); [13]

$$\mathrm{P}_t = \frac{\mathrm{FY1}_t}{\left(1 + \boldsymbol{r}_t^f + \boldsymbol{Q}\beta_t\mathrm{VIX}_t + \boldsymbol{\gamma}SMB_t + \boldsymbol{\delta}HML_t + \boldsymbol{\lambda}MOM_t\right)^a} + \frac{\mathrm{FY2}_t}{\left(1+\boldsymbol{r}_t^f+\boldsymbol{Q}\beta_t\mathrm{VIX}_t+\boldsymbol{\gamma}SMB_t+\boldsymbol{\delta}HML_t+\lambda MOM_t\right)^b\left(\bar{\boldsymbol{r}}_t^f+\boldsymbol{Q}\beta_t\overline{\mathrm{VIX}}-(\boldsymbol{\alpha_0}+\boldsymbol{\alpha_1}\ \mathrm{RGDP10}_t+\boldsymbol{\alpha_2}\ \mathrm{CPI10}_t)^2\right)}. \quad (1')$$

Once we introduce the Fama-French factors it should be acknowledged that the model becomes a hybrid of *ex ante* and *ex post* variables, in our view weakening its appeal. We assume that the Fama-French and Momentum factors are expected to be zero in the long-run so they do not feature in the final part of the denominator of the discounting formula.

We now consider the issue of sentiment effects. We use an investor sentiment index taken directly from the work of Baker and Wurgler (2006) to augment the basic valuation model. The index is a linear combination (principal factor) of six investor sentiment measures that are considered to be clean of endogeneity effects. The index fluctuates around zero which is not necessarily a neutral level of sentiment but is likely to be a close approximation to it. Baker and Wurgler describe their index as an indicator of the propensity to speculate and they describe how this propensity more readily expresses itself in the prices of stocks that are difficult to value. They add;

> "in the case of young, unprofitable, extreme growth stocks the lack of an earnings history combined with the presence of apparently unlimited growth opportunities allows unsophisticated investors to defend, with equal plausibility, a wide spectrum of valuations, from much too low to much too high, as suits their sentiment. During a bubble period, when the propensity to speculate is high, this profile of characteristics also allows investment bankers (or swindlers) to further argue for the high end of valuations. By contrast, the value of a firm with a long earnings history, tangible assets, and stable dividends is much less subjective, and thus its stock is likely to be less affected by fluctuations in the propensity to speculate." . Baker and Wurgler 2007: page

[13] We obtained the Fama-French (and momentum) factors from Kenneth French's web-based data-library.

We account for sentiment effects in terms of implied growth. We include it as an explanatory variable in the long-run growth sub-equation. Since the growth sub-equation is squared this implies that sentiment interacts with the other growth related variables. The motivation for including sentiment in the growth equation is (i) to allow for the effects of cheaper funding, and higher likelihood of investment and expansion actually occurring, when sentiment is high as described in Yuan (2005) and (ii) to allow 'exuberance' or 'gloom' to behaviourally infect expectations of growth when sentiment is very high or very low. Thus, the model 'with sentiment' has the following form, where S is the sentiment index and we revert to a model that excludes the Fama-French variables;

$$\mathrm{P}_t = \tilde{V}_t = \frac{\mathrm{FY1}_t}{\left(1 + \boldsymbol{r}_t^f + \boldsymbol{Q}\beta_t \mathrm{VIX}_t\right)^a} + \frac{\mathrm{FY2}_t}{\left(1+\boldsymbol{r}_t^f+\boldsymbol{Q}\beta_t\mathrm{VIX}_t\right)^b\left(\bar{\boldsymbol{r}}_t^f+\boldsymbol{Q}\beta_t\overline{\mathrm{VIX}}-(\boldsymbol{\alpha_0}+\boldsymbol{\alpha_1}\,\mathrm{RGDP10}_t+\boldsymbol{\alpha_2}\mathrm{CPI10}_t+\boldsymbol{\alpha_3}S_t)^2\right)}. \qquad (2)$$

The growth effects arising from sentiment can be ascertained by examination of the derivatives of the overall growth level with respect to sentiment and real GDP rather than the individual parameter estimates. In our results section we compare the estimated implied growth rates when sentiment is included and excluded, at a sectoral and market level. The main derivative of interest (for neutral sentiment, S=0.0) is; $\frac{dg}{dS_t} = 2\boldsymbol{\alpha_3}(\boldsymbol{\alpha_0} + \boldsymbol{\alpha_1}\overline{\mathrm{RGDP10}} + \boldsymbol{\alpha_2}\overline{\mathrm{CPI10}})$. We evaluate this derivative at the sample average of the variables RGDP10 and CPI10.

Ideally, we would like to impose equality in the risk aversion parameter 'Q' across all stocks. We test this restriction but only find it to be acceptable in about half of the 30 cases considered. It is possible that there is bias in the average level of the estimated stock betas and this is likely to alter the implied risk aversion parameter consistent with a good fit of the price-value relation and render an imposed restriction invalid. Since it is not essential for our analysis, we relax the common risk aversion restriction. We do however present results regarding the testing of this restriction.

At a basic level it is indeterminate whether sentiment should be included as a driver of risk aversion rather than of growth perceptions since both have the same type of effects on the discounting process and would be difficult to decipher econometrically. Including sentiment effects in the risk aversion part of the valuation equation gave rise large effects on other parameters in the valuation metric and gives unreliable or hard-to-interpret results. The inclusion of the VIX in our premium estimate is likely to provide some representation of sentiment effects that are expressed in options markets.

Cointegration and Error Correction

The estimate of stock valuation i.e., the fitted value from the regression allows us to consider how its changes affect subsequent changes in value. More directly, if the estimated intrinsic value is in-fact cointegrated with market value then divergence between the predicted value and the market price can be treated as a disequilibrium that will be corrected on average over time by price changes or valuation changes (or both) to restore equilibrium. Econometrically, this *error correction term* should be a significant driver of market returns if we are to conclude that the fundamental valuation drives price rather than vice-versa. This is also a way to test for overt-fitting biases. If the fit is soley produced by excess complexity this will fail to significantly improve the predictive ability of the implied disequilibrium term. Testing for such effects is an approach taken by previous studies (e.g., Campbell and Schiller, 1988a and 1988b, and Lee et al. 1999). It is also common in the macroeconomic literature on wealth effects and budget constraints, such as, Lettau and Ludvigson (2001), Whelan (2008) and Sousa (2010). Previous studies in the finance field often rely on the price-to-earnings ratio as a disequilibrium driving returns but these ratios are often not well behaved, particularly when the forecast horizon is changing infrequently and when earnings themselves happen to be near zero or are negative. The valuation changes from the valuation model above are more appropriate in an ECM context than price-to-earnings ratios since estimated value is usually close to price and is based on capitalizing more than a single estimate of earnings.

We extend the error correction methodology to encompass disequilibria from the two main equations for valuation (the ‘with’ and ‘without’ sentiment cases). We estimate the following ECM representation for returns;

$$\ln \Delta P_t = \theta_i \ln \Delta P_{t-1-i} + \phi_i \ln \Delta \hat{V}_{1,t-i} + \lambda_i \ln \Delta \tilde{V}_{2,t-i} + \pi_1 ECM_{1,t-1} + \pi_2 ECM_{2,t-1} \tag{3}$$

Where:

i =1 to n depending on significance of parameters and until a white noise error is obtained,

$ln\Delta\hat{V}_{1,t-i}$ is the recent log changes in fitted values from the ‘without-sentiment’ valuation equation,

$ln\Delta\tilde{V}_{2,t-i}$ is the recent log changes in fitted values from the 'with-sentiment' valuation equation,

$ECM_{1,t-1}$ is the lagged error term from the 'with-sentiment' regression (since the regressions are conducted in logs the error can be interpreted as a disequilibrium in the P/$\hat{V}$ ratio),

$ECM_{2,t-1}$ is the lagged gap between the valuation with and without sentiment (where the error can be interpreted as a disequilibrium in the $\hat{V}/\tilde{V}$ ratio),

$\theta_i, \phi_i\ and\ \pi$ are coefficients to be estimated.

In our empirical analysis we test the residuals from the two basic valuation equations for stationarity using standard augmented Dickey-Fuller test restrictions. We also examine whether the ECM regression gives rise to a significantly negative estimates of $\pi_{i,\ i=\{1,2\}}$. Negative coefficients imply that stock returns act to re-equilibrate the relationship between market price and the with-sentiment valuation as well as to reflect the deviation between the 'with' and 'without' sentiment valuations. From this we can ascertain whether market price adjusts more quickly to undo sentiment disequilibrium rather than fundamental disequilibrium. It is plausible that this re-equilibration is not well determined as an average relation but we leave the pursuit of a "threshold" error correction model for future exploration. Furthermore, the ECM result is not necessary for the compilation of the index of the valuation effects of sentiment.

3. Data

Our analysis is applied to the DOW 30 stocks (specifically the DOW 30 members on 30th July 2004 with index weights shown in Table 2). Our sample runs from January 1996 to March 2004. This period includes the dot-com bubble and collapse and also the market reaction to the events of 9/11 2001. For these stocks we obtain the end-of-month price per share and the consensus IBES forecasts of earnings per share. IBES earnings forecasts are 'core earnings' forecasts that ignore many contributions to earnings that are transitory, such as surprise income from the sale of assets, asset revaluations or unusual additions to goodwill. IBES earnings forecasts are up-dated at monthly frequency. However, these forecasts relate to future horizons that change only on an annual basis. The IBES earnings forecasts for a representative member of the DOW 30 are illustrated in Figure 1. The significant jumps occur when the forecast horizon moves from one year-end to another. The FY1 forecast is focused on the next annual earnings report, which can be after the end of the year to which the earnings report pertains. For example, if the year-end is December but the release date of the earnings report is the following March, then the FY1 forecast in December will have an information horizon which is three months beyond the date of the forecast but a value recognition date which is contemporaneous. Likewise, the forecast made in January will often refer back to the year that has just ended in December but for which data has not yet been released. Once the official audited earnings data for the previous year is released the FY1 forecast (such as that made in April) will be for the year ending the following December, a forecast horizon of 8 months. The FY2 forecasts refer to the earnings that are to be released in the year ending 12 months after the FY1 year-end. Thus the maximum distance of the forecast horizon from the date of forecasting is 20 months in the case of FY2.

We employ SPF forecasts of growth-relevant variables.[14] The two variables included are the forecast for the 10 year average growth in real GDP and the forecast for 10 year annual average inflation expected. The average ten year ahead annual growth rate expected in real GDP over the sample period is 2.8%. The average ten year ahead CPI is 2.25%. These variables are not updated at a monthly frequency (they are quarterly). We simply carry forward the most recent quarterly observations to fill-out the missing months. Our valuation is based on nominal earnings and price per share. Since the expected discount rate taken from the SPF is a nominal rate that would be expected to take account of inflation expectations, it is normally appropriate to include only a real growth rate in a Gordon growth-type equation. However we allow for the fact that there may be *money illusion* and also for the fact that expected inflation could act as an indicator for future policy variables that would affect long term earnings growth.

We represent the amount of equity market risk with the VIX index. Specifically, we use a re-scaled value for the VIX in our estimation of equations (1) and (2), VIX/10. In this rescaled form the historical median is 1.888 which is the long-run value assumed to apply (denoted as $\overline{VIX}$ in equation 1). Conventional estimation of beta is backward-looking, based on historical data used in the context of the one factor CAPM. In a recent paper, Christoffersen, Jacobs and Vainberg (2008) argue that computation of time-varying, historic-based betas, or even betas based on ‘realized’ covariance, represent a second best solution. Rather, they propose a

[14] The SPF data is freely available from the Federal Reserve Bank of Philadelphia’s web library, http://www.philadelphiafed.org/research-and-data/real-time-centre/survey-of-professional-forecasters/

method for estimating forward-looking betas from information that is embedded in options prices. Using the single factor CAPM they express the forward looking beta as a function of the implied variance and implied skewness from the distributions of individual stock and index option prices. We make use of the estimates of Christoffersen et al., simply regarding them as an exogenous input into our analysis. These are available at a daily frequency but we take the end of month observations.

We obtained the investor sentiment index developed by Baker and Wurgler (2007) directly from Jeffrey Wurgler's web library. As Baker and Wurgler acknowledge, there are no definitive or uncontroversial measures of investor sentiment. Nevertheless they base their index on a principal components analysis of six well known indicators from previous work by other authors. These include, (i) the closed-end fund discount (CEFD), (ii) NYSE share turnover, (iii & iv) the number and average first-day returns on IPOs, (v) the equity share in new issues, and (vi) the dividend premium. They discuss in detail how each of these indicators is expected to relate to sentiment. While this index is not necessarily equal to zero for neutral sentiment, for expositional purposes, we make this convenient assumption. We chose this measure of investor sentiment in preference to survey based measures to avoid potential endogeneity issues.

4. Results

In this section we discuss the results associated with the regression estimates of parameters and certain partial derivatives of equations (2) and (3). The significance of the regression results and the post regression tests indicate that sentiment has important effects on risk aversion and on the perceptions of growth prospects. The best way to portray these effects is in graphical terms. We therefore calculate and show the proportional contribution of sentiment to valuation of the DOW 30 and of sub-sectors of the market over time based on aggregating the effects at an equity-specific level. The proportional difference between the valuation-fit, 'with' and 'without' sentiment, provides one of our measures of the valuation effects of sentiment. We create an index of the valuation effects of sentiment using relative implied growth rates at a market-wide level and for various sectors. We graphically display a number of other important and interesting auxiliary variables. These include the *ex ante* implied risk premium and the implied Gordon growth-type rates. We discuss how these variables evolve over time and in relation to sentiment. All results were obtained by application of nonlinear least squares estimations that were carried out using the 'NLLS' routine in the RATS© software package.[15]

Price-Value Relation (Full Sample)

The important outputs from the regression results associated with equations (2) and (3) are presented in Table 1, panels A to C. These results pertain to regression analysis using the full sample of data. We return later to results from a rolling regression based on available data at each date. In all cases we show the standard error (or significance level) associated with parameter estimates (test statistics) below the point estimate in parentheses. In the case of equation (2), we present the following;

(i) the estimated risk aversion parameter, 'Q',

(ii) the estimated partial derivative of Gordon growth with respect to sentiment, $\frac{dg}{ds}$,

(iv) stationarity tests on the residuals from this regression (specifically, ADF tests based on Dickey and Fuller, 1979 assessed with critical values from MacKinnon, 1996).

The table also contains results of tests as follows;

(i) a test for the statistical validity of restricting the risk aversion parameters to be equal to 0.015 (approximately the average of the stock-specific estimates) and,

(ii) a test for the exclusion of the Fama-French and momentum factors (where a more general model was estimated to perform the test).

Finally, in the case of equation (3) – the ECM regression – we show the following;

(i) the ECM parameter estimates π_1 and π_2, and,

(ii) the adjusted R-squared for the returns regression.

It can be seen from the results in Column 1 of Table 1 that the estimated risk aversion parameter, Q, is significantly positive in most cases and has a magnitude that is consistent with a reasonably sized risk premium. In the one case where it is negative it is statistically insignificantly different from zero. The average size of Q is approximately 0.015. The risk

[15] The RATS code is available from the authors on request.

premium is the product of Q and the VIX index (divided by 10) so we can conclude that the implied risk premium is approximately 3.5% on average.[16] The cross-stock variation in estimated Q is not large once certain outliers are excluded. There are 15 stocks with estimates for Q lying between 0.011 and 0.019. Figure 2 shows the *ex ante* risk premium implied by Q=0.015 which is simply multiplied by the VIX index.

The effect of sentiment is given by the estimate of the derivative $\frac{dg}{dS}$ which is shown in Column 2 of Table 1 (evaluated at average values of GDP10 and CPI10). This shows the point estimate of the effect of sentiment on the long-run growth in earnings.[17] This has the expected positive sign in 25 cases and it is highly statistically significant in 19 cases. The range of values for this parameter is quite large (with 1st and 3rd quartiles equal to 0.055 and 0.57 respectively). This variability probably reflects the differential effects of sentiment due to different firm characteristics as described by Baker and Wurgler (2007). We would expect well established manufacturing firms to be less affected by sentiment and firms in new growth sectors to be more affected. A view of the growth effects that are implied by the 'with' and 'without' sentiment regressions can easily be seen by plotting the terms $(\boldsymbol{\alpha_0} + \boldsymbol{\alpha_1} \text{ RGDP10}_t + \boldsymbol{\alpha_2}\text{CPI10}_t)^2$ and $(\boldsymbol{\alpha_0} + \boldsymbol{\alpha_1} \text{ RGDP10}_t + \boldsymbol{\alpha_2}\text{CPI10}_t + \boldsymbol{\alpha_3}S_t)^2$ respectively. Figures 3 shows these implied growth rates for the Finance stocks, Technology stocks and other stocks over the sample. This confirms the fact that sentiment contributes significantly to implied growth (particularly around the dot-com period) and it also shows that Finance and Tech stocks were more prone to these effects. The divergence between growth rates implied by the 'with' sentiment valuation and that implied by the 'without' sentiment valuation begins sometime in early 1999. The peak of the 'with' sentiment implied growth rate series occurs a year after the collapse of the dot-com bubble in March 2000.

Table 1, Column 3 shows the ADF test results for the residuals from equation (1). Cointegration is a concept that is not well established in the context of non-linear relations. However, after capitalization of earnings it is plausible that the underlying price-value relation is linear implying that the residuals from the main regression should be stationary and amenable to stationarity testing in the usual way, and that an *error correction representation*

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[16] Christoffersen *et al.* refer to the potential presence of slight bias in their forward looking betas when they compare them with other beta measures such as the *realized* beta (see Andersen, Bollerslev, Diebold and Wu 2006). So the implied premium may be understated slightly.

[17] The 'summarize' function in RATS allows post-regression evaluation of combinations of coefficients and produces standard errors for these combinations.

is also valid. Much of the sensitivity of residual based tests of cointegration concerns the number of variables in the relation and whether there is a constant and trend in the cointegrating relation. We have been rigorous in not allowing any constant or trend in the estimation of equation 2. Assuming the basic underlying relation is linear we use critical values for the ADF test of stationarity of the residuals from equation 2 based on the work of MacKinnon (1996).[18] We find that all of the regressions have residual series that can be rejected as non-stationary at the 5% level of significance or better. We conclude from this that the price and fitted value based on equation 2 are cointegrated. The same conclusion can be made about the difference between the fitted values from the 'with' and 'without' sentiment versions of the model but we omit this result from Table 1 for clarity of exposition. At a 'meta' level there is strong evidence for cointegration using this valuation approach.

Column 4 in Table 1 has results for the tests of the restriction that the stock-specific risk aversion parameter is equal to 0.015 which is the average of the estimates from all stocks. This test statistic is Chi-Square distributed under the null of acceptance. We find that the restriction is rejected in 17 cases. Importantly however, we found that there was very little impairment of the growth effects of sentiment even when the restriction was imposed.[19] Column 5 contains test results for the joint exclusion of Fama-French and Momentum factors. The exclusion of these factors is jointly accepted in two-thirds of cases.

The results from estimation of equation (3) are provided in columns 6 to 8 of Table 1. In column 6 we show the parameter estimate on the lagged price/value ratio, where the value is from the 'with' sentiment regression. We expect this parameter to have a negative sign and this is confirmed in 27 cases out of 30. However, only a small number of these are significantly negative using the MacKinnon critical values (there are two coefficient estimates that are significantly negative at the 10% level, 3 at the 5% level and 2 at the 1% level). Thus,

[18] We use estimates of 1%, 5% and 10% critical values for ADF, from MacKinnon 1996, with N=1, assuming no constant or trend in the cointegrating relation. For any sample size T, the estimated critical value is $\beta_\infty + \beta_1/T + \beta_2/T^2$ where the following table provides the required parameters and the ADF critical values (cv) used in our analysis in the final column;

Level	β_∞	β_1	β_2	ADF cv
1%	-2.5658	-1.96	-10.04	-2.58662
5%	-1.9393	-0.398		-1.94332
10%	-1.6156	-0.181		-1.61743

[19] In earlier versions of this paper we imposed a common risk aversion parameter based on the estimated risk aversion in the case of an "easy-to-value" stock. We picked the "easy-to-value" stock using characteristics suggested by Baker and Wurgler (2007). The results were not qualitatively different from what we present here.

it is difficult to find strong evidence that market price adjusts in response to this implied mis-valuation at a stock-specific level. However, with the vast majority of coefficients negative it is likely that there is a significant error correction effect at a portfolio level. The 7^{th} column contains the results for the other error correction term (the lagged deviation between the 'with' sentiment valuation and the 'without' sentiment valuation). In this case the results is slightly weaker, with 22 negative estimates only 3 of which are significant using the MacKinnon critical values. Once again however, at a 'meta' level, we regard this as evidence in favour of re-equilibration in respect of this disequilibrium. Overall there is evidence that both of the disequilibria are reversed by appropriately signed future returns but the effect is not strong. However, it should be noted that the effect may be difficult to identify as an average relation. If there are infrequent 'corrections' responsible for re-equilibration then the ECM parameter estimates may not fully reflect this since they are based on an average relation present over the whole sample. We present the $\bar{R}^2$ from the ECM regression in the last column. Twenty five of these are positive, with 16 greater than 5% and 7 that are above 10%. While it is desirable to have good predictive power in the ECM regression this is not a necessary condition for obtaining a good indicator of the valuation effects of sentiment (which is a 'levels' rather than 'returns' concept). Since the ECM term and the other variables are given in percentage terms the speed of error correction from the ECM parameter estimates can be inferred. The median value of the ECM parameters estimates on both ECM terms is approximately -0.05. If the disequilibria are on average 10% of price, then returns adjustment each period may be as great as 0.5% of the price level. The longer term adjustment can be assessed by regressing lower frequency returns on past disequilibrium but we leave this for future work.

Valuation Effects of Sentiment

The valuation effects of sentiment are very apparent when the two fitted valuations and the price are presented graphically. Figure 4 shows this for the case of Hewlett-Packard. Clearly, the stock market price during the period of the dot-com bubble is not well tracked by the pure fundamentals based valuation. Once the investor sentiment variable is allowed to interact with the valuation metric we get better fits for this period. Such sentiment effects can be detected in a number of specific cases. Figure 5 shows the 'with' and 'without' valuations for different sectors and for the market as a whole. The Finance and Technology sectors, for example, are well tracked by the sentiment valuation and there is a significant difference between the 'with' and 'without' sentiment valuations in these cases. In the case of 'other stocks' the sentiment effect is less perceptible.

To obtain an aggregate (or sector-specific) valuation effect from sentiment we calculate the weighted sum of $(\tilde{V}/\hat{V})$ for the stocks of interest (where the weights are the DOW index weights). This measure shows how sentiment contributes to over- and under-valuation in a proportional sense. Since the 'with' sentiment valuation can overshoot stock price it is important to interpret the measure just proposed as a stochastic variable that embodies a frontier somewhere near its local average. Based on a visual inspection of the equity-specific relative valuations, the 'with' sentiment valuation is mostly between the 'without' sentiment valuation and price when the two valuations are most different from each other. We make some tentative suggestions later regarding what can be considered to be a 'significant' gap between the two valuations.

Figure 5 shows the effects of sentiment on valuation for the case of finance stocks, technology stocks, other stocks and DOW30 stocks. An important conclusion is that the valuation effects that can be attributed to sentiment are quite large. When the sentiment index is at its peak, the valuation effect attributable to sentiment for Technology and Finance stocks is about 50% in excess of the 'without' sentiment valuation. The largest effects are in the Finance sector. The stocks denoted as 'other' are not greatly endowed with value attributable to sentiment. It is also important to note that the valuation effects attributable to sentiment can be negative. This is true of the last 3 quarters of 2002 and most of 2003 for the Finance stocks.

Based on this index of value attributable to sentiment, the dot-com bubble doesn't show-up until relatively late and when it appears it is relatively strong. According to this measure the beginning of the dot-com bubble is apparent from November 1999 when the index of value attributable to sentiment (Finance sector) first breached 1.10. It quickly rose to approximately 1.30 in December 1999. This elevated reading lasted until the end of March 2000 often cited as the date of the bursting of the dot-com bubble. The index then declined for a 2 month period to near normal levels before rising again to almost 1.65 in August 2000. This return to elevated levels confirms views expressed by Shiller (2000) that the market was still unrealistically priced in late 2000 despite the large market correction earlier in the year. A decline to more normal levels occurred again in March of 2001. We also note that this index temporarily declined again in September 2001 to 0.91 following the 9/11 attacks. But the effect was short-lived until about 6 months later when sentiment was low again and the valuations of sentiment-prone stocks were particularly negatively affected.

The tardy signal regarding the appearance of the dot-com bubble produced by the valuation ratio may reduce its appeal as an early warning indicator. However, an analysis of the implied growth rates looks more promising. Also, a careful analysis of the components of the valuation equation indicate an increasing potential for larger than average movements relating to sentiment. The early 1999 divergences between implied growth rates ('with' and 'without' sentiment) give an earlier warning of mis-valuation than the comparison of the 'with' and 'without' sentiment valuations. This reflects the fact that growth rate variability feeds through as smaller valuation effects if at the same time interest rates rise. The larger is the gap between the interest rate (plus the risk premium) and the implied growth rate, the smaller will be the effect of an increase in expected growth on value. We therefore consider whether the relative implied growth rates themselves could act as an early warning indicator. Figure 6 shows the relative growth rates implied by the 'with' and 'without' sentiment valuations (analogous to the valuation ratios shown in Figure 5). This shows that the relative growth attributable to sentiment was on the rise in mid 1999. It also indicates that implied growth was largely sentiment driven in the early 1990s for the DOW as a whole.

An advantage of using the implied growth rates in statistical terms is that growth rate estimates are likely to have simpler statistical properties than the valuations. This facilitates construction of a significance level for the rejection of the hypothesis that the 'with' sentiment implied growth is different from the 'without' sentiment implied growth. While such a test is not a measure of how different the valuations are under the two models it is likely to be easier to reject them as similar the larger is the magnitude of the gap. The implied growth rates are restrained to be positive, since we square the growth sub-equation during estimation. Under the null hypothesis of no difference between the 'with' and 'without' sentiment implied growth rates, we can regard the ratio of the average estimated growth rates from the 'with' and 'without' sentiment valuations as a ratio of quasi Chi-Squared distributed variables, which produces a ratio that is F-distributed under the null. This in-turn allows us to make statements with statistical confidence regarding the likelihood of sentiment effects being present. For the case of the DOW, there are 30 observations in each period and therefore the F-statistic will be $F(30,30)$ distributed under the null. Smaller groupings of stocks (such as

Finance stocks) will obviously lead to F-statistics with fewer degrees of freedom and this reduces the confidence with which the null hypothesis of 'no difference between valuations' can be rejected.

The significance levels for the F-statistics based on the ratio of average implied growth rates from the two valuations and for different groups of stocks are shown in Figure 7. The smaller is the significance level the higher the level of confidence with which we can say the valuations are different. We include the 10% bar in the plots to show when the null hypothesis can be rejected with more than 90% confidence. We can observe from the first of these plots that the dot-com bubble is associated with a rejection of similarity between the valuations with 90% confidence. This occurs as early as September 1999 for the tests based on the DOW 30. Whatever about the prescience of this measure it is clear that when the significance level reaches virtually zero and remains there for a long time this should be taken as a clear signal that the 'with' and 'without' valuation differences are very unusual and should either produce arbitrage or prompt policy initiatives to bring valuations more in line with fundamentals.

Out-of-sample results

In this section we give a heuristic account of an out-of-sample analysis. While such an analysis is fraught with difficulty due to the non-linear, complex and unstable nature of the underlying relationship, we present it as an insightful exercise. To get an indication as to how sentiment variation may translate into valuation effects in real time we conduct the 'with' sentiment regression for an initial sample running from January 1996 to December 1999 and obtain one-step-ahead fits for the following components of the valuation equation; (i) implied growth, (ii) the required return on equity and (iii) the valuation fit. Thus, we base the fit on the value of the explanatory variables in the period ahead using the parameter estimates derived from a regression using a sample that predates this period. We then roll the regression forward each period recalculating the parameters (when possible) and deriving a one-step-ahead fit for the same three components for the next period.

An analysis of the components of the valuation equation reveals how the valuation fit sometimes behaves in an unstable way due to a high sensitivity to movements in g when $r^e - g$ is close to zero. Indeed, it is possible for predictions of g to exceed the predicted required return on equity. This produces a negative valuation fit. This is not just an issue for the out-of-sample context. When parameter estimates are based on a short enough sample, large outliers will also give rise to in-sample negative valuation fits for which the taking of logs is an invalid operation given that our regression fits log of price with the log of value. The best course of action in this case is to drop the offending observations from estimation until a sufficient number of new observations are available with which to obtain non-negative valuation fits. We know from the original analysis above that this happens for all periods when the sample is large enough. As it turns out, the problem of negative one-step-ahead forecasts of value occurs mostly for those firms that are most prone to sentiment effects and it often takes a large number of new observations to be included before the problem is solved.

While it may seem that dropping observations from estimation is a deficiency of the methodology presented here we do not consider it so. When the out-of-sample prediction produces $g > r$ this outcome is informative even when the estimates upon which the prediction is based are a little out-of-date. What it indicates is that sentiment effects are likely to cause problems for agents in ascertaining the underlying value of stocks. It tells us that the valuation exercise in such circumstances is very sensitive to changes in the drivers of growth or required return on equity. If a large part of predicted growth is attributable to sentiment then this should act as a warning that the market is becoming prone to significant sentiment effects. It signals a need to monitor how the increased fragility of the market is feeding into risk aversion and predicted volatility.

Figure 8 (panel A) shows out-of-sample predictions of growth and required return on equity implied by the estimated parameters from equation 2. The gap between required return and growth is shown in panel B. We use a weighted average of the growth and required return predictions for the case of a portfolio of non-finance and non-technology stocks (those stocks where the problem of dropped observations just discussed is not prevalent). This reveals a sharp rise in the expected growth in Jan 2000 when there was a spike in investor sentiment. Over the periods that follow, the regression is updated and since sentiment levels remained relatively high, the estimated responsiveness of growth to sentiment declines (to ensure a better fit). Predicted growth therefore falls progressively for a number of periods. Nevertheless the gap between growth and required return remains relatively small and a second wave of sentiment drives predicted growth up again towards the beginning of 2001. The gap between expected growth and required return remains small for most of 2001 after which there is a return to more normal levels. Predicted valuations (untabulated) are often very large relative to market valuation during periods when there is a small gap between required return and growth. It might be expected that the VIX would rise in these circumstances but we did not find this to be the case. A rise in the VIX would have helped to stabilize valuations because the required premium would then have compensated for the measurable increase in risks associated with outstanding growth predictions based largely on sentiment movements. The lack of a reaction of this type remains somewhat puzzling and could have been viewed by policy makers as a signal of a market failure.

5. Conclusion

We use a well know and widely accepted valuation metric, the Gordon Growth model, as a basis for introducing measurable valuation effects of investor sentiment. Identifying value attributable to sentiment is a significant step beyond how sentiment effects are evidenced in the extant literature. This produces a policy-relevant tool and an indicator that can be used to understand potential causes and effects. We apply non-linear regression techniques to fit the price-value relation 'with' and 'without' sentiment. We use *ex ante* variables throughout and introduce new variables that improve the reliability of the valuation approach. These include forecasts of macroeconomic variables, options-based measures of risk and forward-looking betas. We apply restrictions during estimation that maintain credible projections for growth rates and required rates of return. Moreover, we propose an index of the value-relevance of sentiment and show how this can be assessed in statistical terms. We find that a large proportion of market valuation can be attributed to sentiment. This shows that sentiment effects are more pervasive than usually understood. While the dot-com boom is identified as a period of excessive exuberance sentiment effects are shown to extend well beyond that episode. An out-of-sample analysis shows that the projections for growth can exceed projected required rates of return when there are spikes in sentiment and we argue that this is informative. By breaking down projections into components relating to growth and required return it is easier to identify when sentiment effects and policy changes will have most effect.

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Figures and Tables

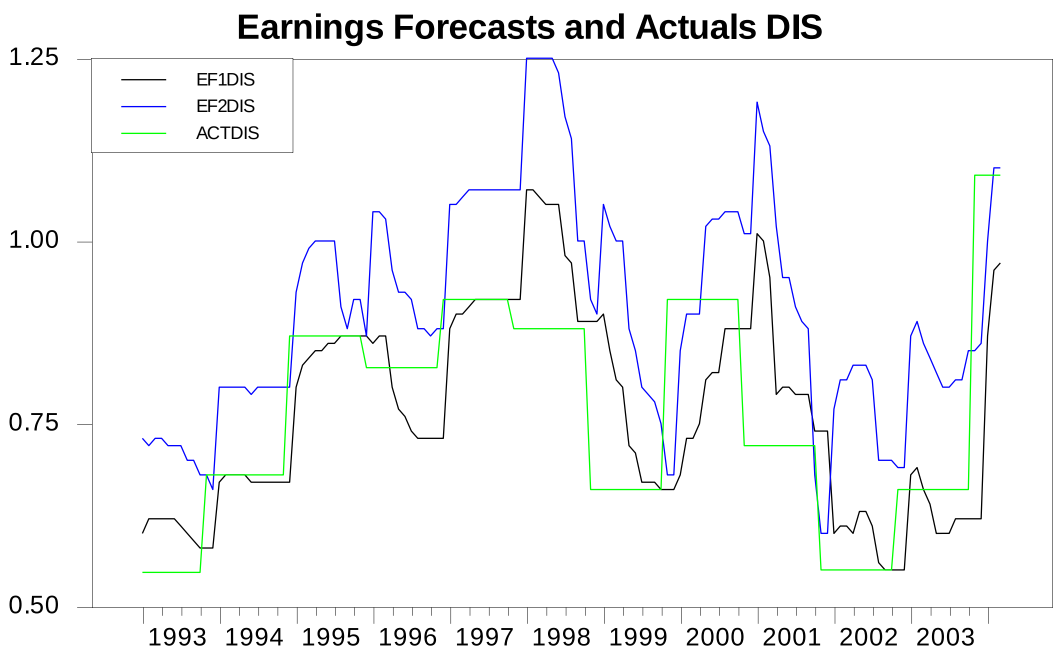

Figure 1. DIS Inc (Disney). EF1 and EF2 denote IBES Earnings Per-Share (EPS) forecasts for the current year (or if not yet released, the most recent year) and for the following year-end respectively. ACT denotes the actual reported earnings. The reported EPS are adjusted for stock splits so that the old numbers are directly comparable with EPS figures most recently available for DIS.

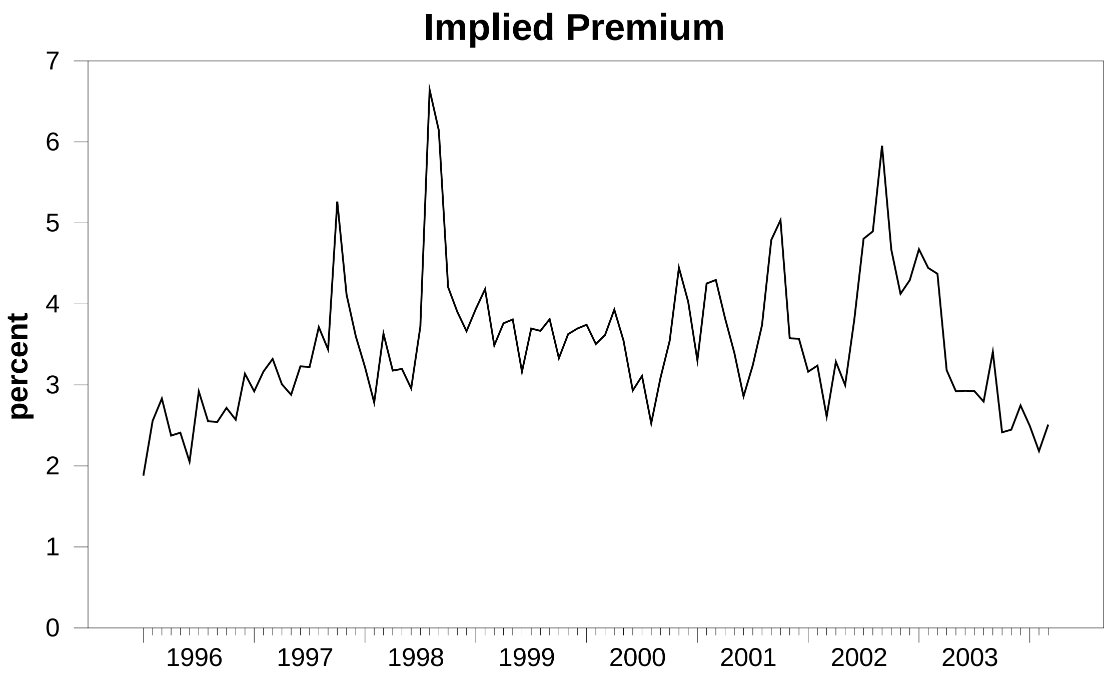

Figure 2: The *ex ante* premium associated with Q=0.015.

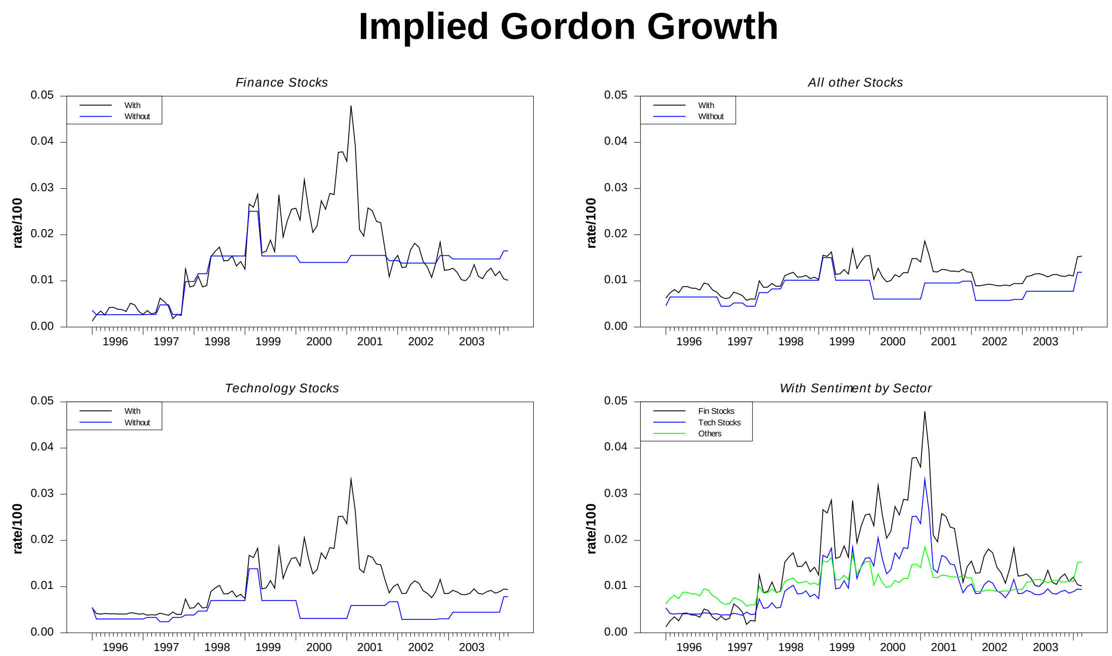

Figure 3: The two graphs in the first column contain plots of the weighted averages of the implied growth rates 'with' and 'without' sentiment in each period for stocks within the Finance and Technology sectors (the weights are the index weights). The top graph in the second column contains the same variable for all other stocks in the Dow 30. The lower graph in the second column contains plots of the implied growth rates for the three sectors 'with' sentiment.

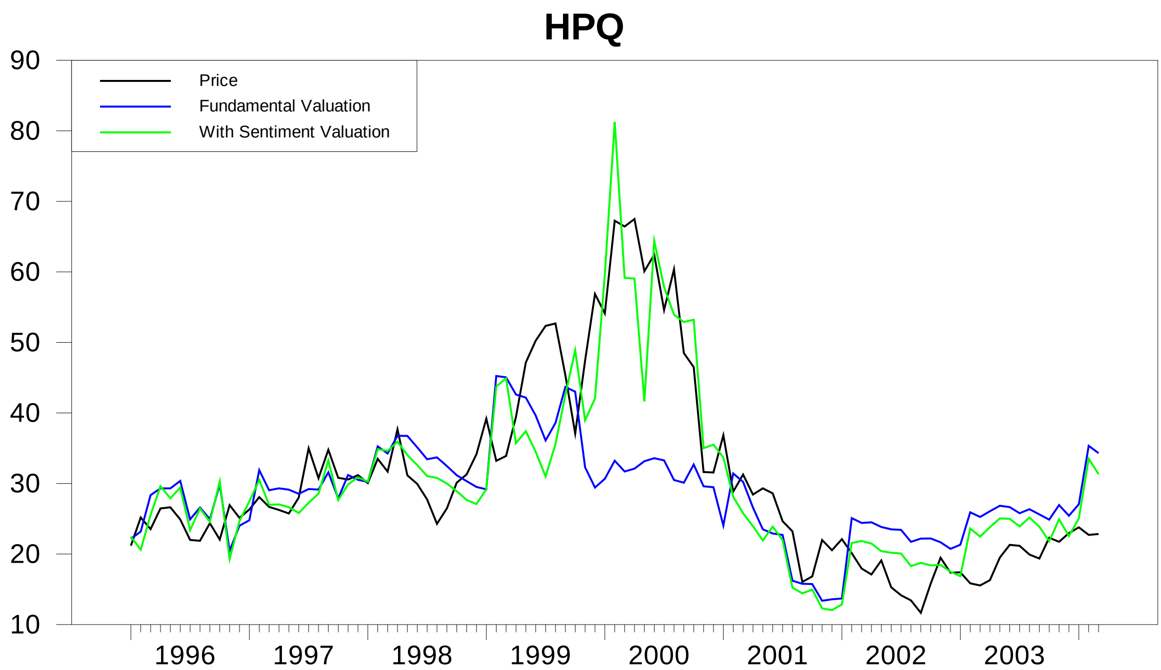

Figure 4: An example of valuations 'with' and 'without' sentiment. The Price per share of Hewlett-Packard stock and the valuation per share based on fundamentals alone and based on investor sentiment in addition to fundamentals.

Index of Value Attributable to Sentiment

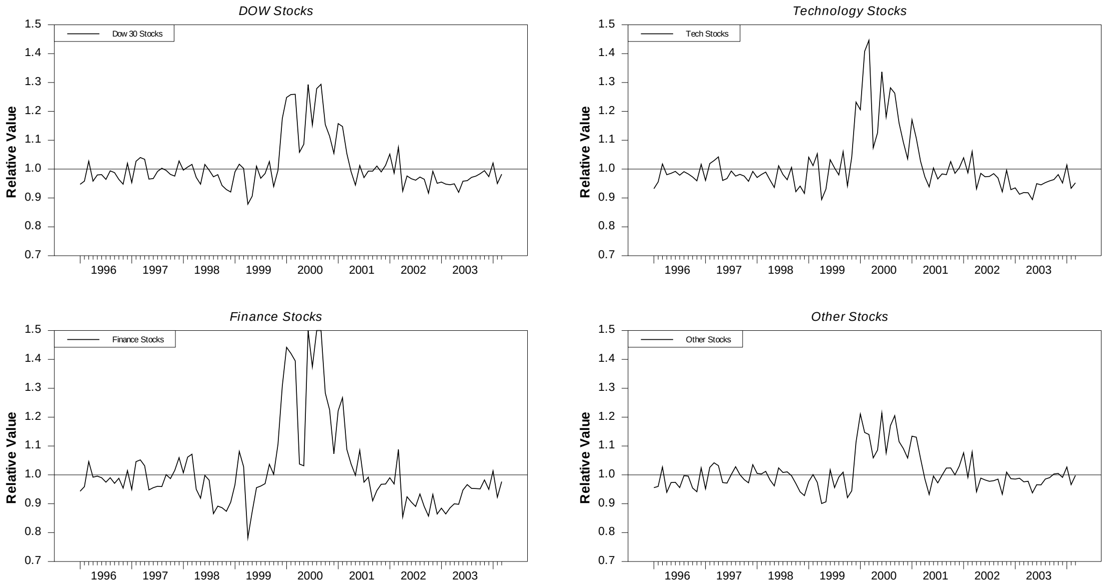

Figure 5: These plots show the average of 'with' sentiment valuation relative to the 'without' sentiment valuation for Finance, Technology, Other Stocks and the DOW 30. The weighted averages are based on the DOW 30 weights.

Index of Implied Growth Attributable to Sentiment

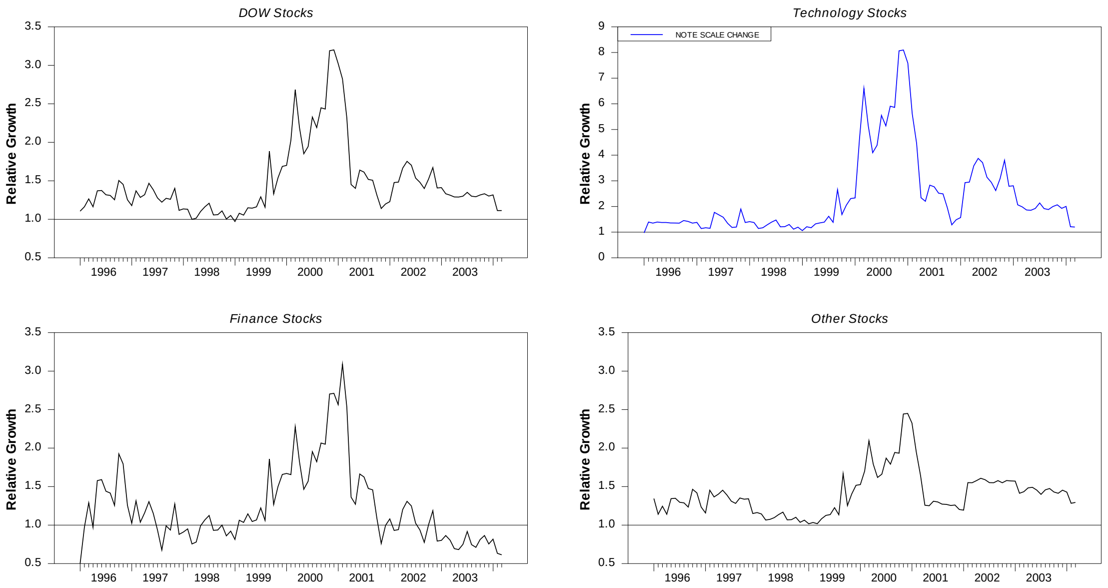

Figure 6: These plots show the average of 'with' sentiment implied growth relative to the 'without' sentiment implied growth for Finance, Technology, Other Stocks and the DOW 30. The weighted averages are based on the DOW 30 weights. Note the change of scale for the case of Technology stocks.

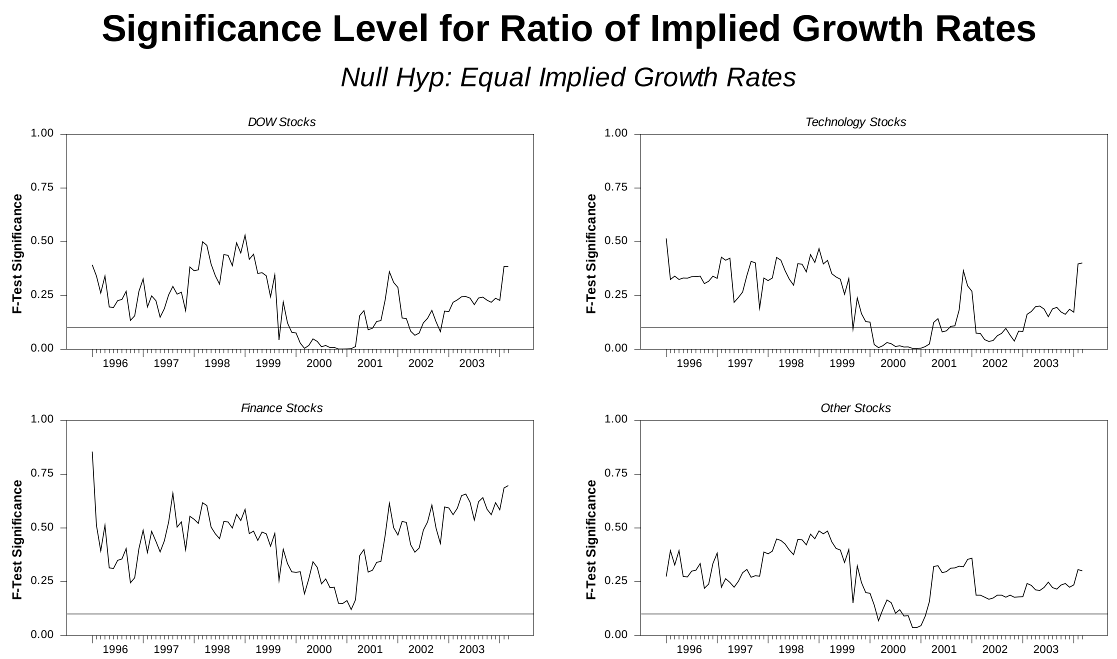

Figure 7: These plots show the significance levels for the ratio of 'with' and 'without' sentiment implied growth rates for Finance, Technology, Other Stocks and DOW 30 stocks. The 0.10 line is given as a benchmark for rejecting the hypothesis of no difference between the implied growth rates. The degrees of freedom for the tests are dependent on the number of stocks used to obtain the average each period (DOW = 30, Finance = 5, Technology = 8, Other = 17).

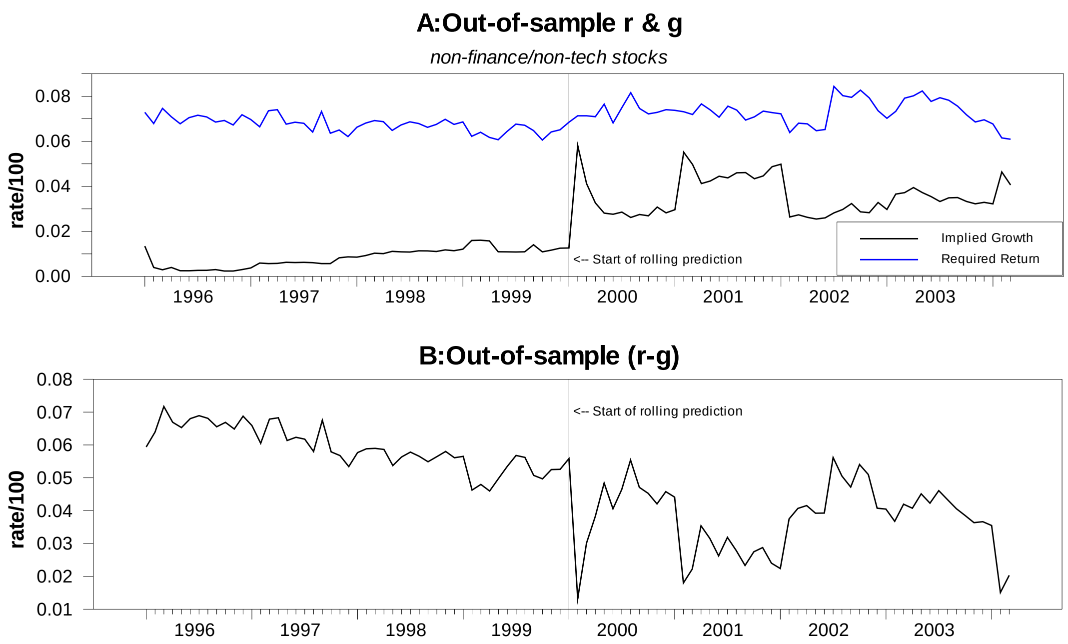

Figure 8: For the case of non-financial firms and non-technology firms we show the weighted average of the implied growth and the required rate of return based on parameter estimates from the regression based on equation (2). The pre-sample period is January 1996 to December 1999. The regression rolled forward to include available information before the one-step-ahead predictions are calculated. Panel A shows the predicted growth and required return separately. Panel B shows the gap between required return and predicted growth.

Table 1, Panel A.

Equity	Q	$\frac{dg}{dS}$	ADF	Chi-Sq-Test $\{Q; 0.015\}$	F-Test FF-factors	ECM π_1	ECM π_2	ECM R^2
Alcoa (AA)	0.021***	-0.143	-4.033***	12.83***	1.238	-0.032	-0.082	0.000
	(0.002)	(0.131)		(0.00)	(0.294)	(0.051)	(0.322)	
Am Exp (AXP)	0.015***	0.574***	-3.256***	0.023	1.174	-0.032	-0.171**	0.057
	(0.002)	(0.092)		(0.879)	(0.318)	(0.053)	(0.086)	
AIG (AIG)	0.015***	0.715***	-4.427***	0.002	2.317*	-0.048	-0.047	0.001
	(0.002)	(0.092)		(0.968)	(0.073)	(0.046)	(0.055)	
Boeing (BA)	0.013***	0.221**	-4.94***	4.146**	0.07	0.023	0.023	-0.003
	(0.001)	(0.093)		(0.042)	(0.976)	(0.054)	(0.206)	
Caterpillar (CAT)	0.027***	-0.822^{++}	-3.359***	33.645***	2.641**	-0.066	0.084	0.009
	(0.002)	(0.34)		(0.00)	(0.048)	(0.045)	(0.108)	
J P Morgan (JPM)	0.029***	0.298	-4.668***	49.025***	0.859	-0.101*	-0.232	0.092
	(0.003)	(0.193)		(0.00)	(0.461)	(0.059)	(0.213)	
City (C)	0.024***	0.72***	-4.115***	13.974***	2.314*	-0.105*	-0.032	0.038
	(0.002)	(0.144)		(0.00)	(0.074)	(0.06)	(0.097)	
Coca Cola (KO)	0.000	0.321***	-2.8***	76.57***	0.674	-0.036	-0.003	0.045
	(0.002)	(0.115)		(0.00)	(0.568)	(0.039)	(0.121)	
Disney (DIS)	0.008***	0.493***	-4.374***	11.885***	0.927	-0.052	-0.07	0.009
	(0.002)	(0.091)		(0.001)	(0.427)	(0.054)	(0.091)	
Du Pont (DD)	0.012***	0.003	-3.078***	2.471	0.432	-0.085**	1.867	0.039
	(0.001)	(0.022)		(0.116)	(0.73)	(0.04)	(4.243)	

Table 1 (Panel A): Columns 1 and 2 contain estimates (std. errors in parentheses) of the risk aversion parameter, 'Q', and the derivative of the implied Gordon growth rate with respect to sentiment from estimation of equation (2); $P_t = \widehat{V}_t = FY1_t/\left(1 + r_t^f + Q\beta_t \mathrm{VIX}_t\right)^a + \mathrm{FY2}_t/\left(1 + r_t^f + Q\beta_t \mathrm{VIX}_t\right)^b \left(\bar{r}_t^f + Q\bar{\beta}\overline{\mathrm{VIX}} - g_t\right)$, where, $g_t = \left(\alpha_0 + \alpha_1\, \mathrm{RGDP10}_t + \alpha_2\, \mathrm{CPI10}_t + \alpha_3 S_t\right)^2$. Column 3 contains the ADF statistic testing for stationarity of the residuals from equation (2). Column 4 contains results of the test (significance level in parentheses) of the restriction that the equity-specific risk aversion parameter is equal to the mean value of estimates across stocks. Column 5 shows the test statistic (and significance level) for the joint significance of Fama-French and momentum factors. Columns 6 and 7 contain estimates of π_1 and π_2 from the ECM regression show as equation (3) in the text; $\ln \Delta P_t = \theta_i \ln \Delta P_{t-1-i} + \phi_i \ln \Delta \widehat{V}_{t-i} + \lambda_i \ln \Delta \widetilde{V}_{t-i} + \pi_1\, ECM_{1,t-1} + \pi_2\, ECM_{2,t-1}$, where $ECM_{1,t-1} = ln\left(P/\widehat{V}\right)_{t-1}$ and $ECM_{2,t-1} = ln\left(\widehat{V}/\widetilde{V}\right)_{t-1}$. The $\bar{R}^2$ statistic for the ECM regression is shown in the final column. Significant coefficient estimates at 10, 5 and 1 percent are indicated by *, ** and * respectively. We change these to $^{+,\,++,\,+++}$ if the sign of the coefficient is opposite to what was expected.**

Table 1, Panel B.

Equity	Q	$\frac{dg}{dS}$	ADF	Chi-Sq Test $\{Q; 0.015\}$	F-Test FF-factors	ECM π_1	ECM π_2	ECM R^2
Exxon (XOM)	0.011***	0.245***	-3.422***	2.018	0.156	-0.051	-0.052	-0.015
	(0.003)	(0.063)		(0.155)	(0.926)	(0.042)	(0.139)	
Gen Elect (GE)	0.012***	1.011***	-3.25***	1.531	3.819***	-0.018	-0.002	-0.022
	(0.002)	(0.099)		(0.216)	(0.009)	(0.037)	(0.04)	
Gen Motor (GM)	0.063***	-0.422	-3.921***	69.09***	1.41	-0.027	0.359	0.036
	(0.005)	(0.499)		(0.00)	(0.238)	(0.034)	(0.284)	
Hewlett-Pac (HPQ)	0.011***	0.584**	-3.774***	0.86	0.413	-0.114**	-0.076	0.064
	(0.004)	(0.248)		(0.354)	(0.744)	(0.05)	(0.134)	
Home Depot (HD)	0.009***	0.84***	-3.132***	3.853**	0.62	-0.019	-0.041	-0.013
	(0.003)	(0.124)		(0.05)	(0.602)	(0.036)	(0.051)	
Honeywell (HON)	0.016***	-0.151	-5.683***	1.305	5.064***	-0.118	0.085	0.099
	(0.001)	(0.115)		(0.253)	(0.002)	(0.091)	(0.336)	
Intel Corp. (INTC)	0.004**	0.343***	-2.935***	23.229***	2.985**	-0.081	-0.203	0.074
	(0.002)	(0.129)		(0.00)	(0.03)	(0.064)	(0.165)	
IBM (IBM)	0.016***	0.556***	-3.994***	0.206	2.645**	-0.139***	0.019	0.104
	(0.003)	(0.141)		(0.65)	(0.047)	(0.043)	(0.067)	
Johnson & J (JNJ)	0.006***	0.445***	-2.289**	26.088***	0.727	0.03	-0.032	0.133
	(0.002)	(0.054)		(0.00)	(0.536)	(0.05)	(0.089)	
MacDonald (MCD)	0.015***	0.464***	-3.641***	1.157	0.147	-0.012	-0.28**	0.101
	(0.002)	(0.098)		(0.282)	(0.931)	(0.052)	(0.114)	

Table notes as for Panel A.

Table 1, Panel C.

Equity	$\boldsymbol{Q}$	$\frac{\boldsymbol{dg}}{\boldsymbol{dS}}$	**ADF**	Chi-Sq Test $\{\boldsymbol{Q}; \mathbf{0.015}\}$	F-Test FF-factors	ECM π_1	ECM π_2	ECM R^2
Merck (MRK)	0.013*** (0.003)	0.753*** (0.101)	-3.554***	0.776 (0.378)	0.347 (0.791)	-0.016 (0.044)	-0.005 (0.074)	0.131
Microsoft (MSFT)	0.004*** (0.001)	0.509*** (0.106)	-4.1***	80.901*** (0.00)	1.292 (0.275)	-0.073 (0.052)	-0.158 (0.114)	0.120
3M (MMM)	0.006*** (0.001)	0.069 (0.053)	-5.011***	252.1*** (0.00)	3.197** (0.022)	-0.231*** (0.075)	0.047 (0.326)	0.090
Pfizer (PFE)	0.013*** (0.004)	0.826*** (0.134)	-2.366**	0.403 (0.525)	0.027 (0.994)	0.036 (0.027)	0.003 (0.047)	0.132
Altria (MO)	0.041*** (0.004)	-0.981 (0.714)	-3.229***	56.416*** (0.00)	2.453* (0.061)	-0.042 (0.046)	-0.388 (0.301)	0.009
Proctor (PG)	0.006*** (0.002)	0.044 (0.073)	-3.243***	23.762*** (0.00)	1.755 (0.153)	-0.037 (0.054)	-2.374** (1.194)	0.216
AT&T (SBC)	0.019*** (0.002)	0.555*** (0.126)	-4.498***	7.111*** (0.008)	0.344 (0.794)	-0.059 (0.065)	-0.097 (0.083)	0.075
United Tech (UTX)	0.014*** (0.001)	0.050 (0.10)	-5.278***	1.327 (0.249)	1.407 (0.239)	-0.135 (0.086)	-0.07 (0.172)	0.060
Verizon (VZ)	0.017*** (0.001)	0.308*** (0.094)	-5.469***	5.855** (0.016)	2.75** (0.041)	-0.226** (0.089)	-0.02 (0.143)	0.077
Walmart (WMT)	0.004** (0.002)	0.46*** (0.073)	-3.522***	37.52*** (0.00)	1.104 (0.346)	-0.02 (0.047)	-0.059 (0.074)	-0.049

Table notes as for Panel A.

Ticker	Name (Index Weight)	Ticker	Name (Index Weight)
AA	ALCOA INC (2.31)	HON	HONEYWELL (2.57)
AXP	AMERICAN EXPRESS (3.67)	INTC	INTEL CORP (1.89)
AIG	AMERICAN INTL (5.13)	IBM	IBM (6.24)
BA	BOEING CO (3.55)	JNJ	JOHNSON & JOHNSON (3.97)
CAT	CATERPILLAR (5.50)	MCD	MCDONALDS (1.87)
JPM	J P MORGAN (2.73)	MRK	MERCK & CO (3.36)
C	CITIGROUP INC (3.28)	MSFT	MICROSOFT (2.05)
KO	COCA COLA CO (3.62)	MMM	3M CO (6.27)
DIS	DISNEY WALT CO (1.81)	PFE	PFIZER INC (2.43)
DD	DU PONT (3.12)	MO	ALTRIA GROUP (3.56)
XOM	EXXON MOBIL (3.21)	PG	PROCTER & GAMBLE (3.89)
GE	GENERAL ELEC CO (2.27)	T/SBC	AT&T / SBC COMM INC (1.73)
GM/MTLQQ	GENERAL MTR LIQ CO (3.24)	UTX	UNITED TECH (6.42)
HPQ	HEWLETT PACKARD (1.46)	VZ	VERIZON (2.59)
HD	HOME DEPOT INC (2.49)	WMT	WAL MART (3.72)

Table 2: Ticker symbols and names for the stocks under analysis and the index weights as at 5th July 2004.