The relationship between uncertainty and the market reaction to information: Is it influenced by stock-specific characteristics?

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Abstract: In recent times we have seen an increased interest in separating information signals into good and bad news in order to gain improved insight into the reaction of investors. When we make this separation we find that the behaviour of investors oscillates between being optimistic and pessimistic in their interpretation of information somewhat driven by the prevailing level of uncertainty at the time of the information release. We go on to show that investors' reaction to information is not only conditioned by uncertainty but also a significant number of firm-specific characteristics. The reaction to bad news is greatest when it is released at times of high uncertainty by large, less liquid, low idiosyncratic risk, low leveraged, value stocks that are experiencing abnormally high trading volume. The reaction to good news is greatest when it is released at time of low market uncertainty by large, less liquid, high idiosyncratic risk, low leveraged, value stocks that are experiencing abnormally high trading.

Keywords: investor reaction; information; uncertainty; stock characteristics.

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1 Introduction

Although event studies now date back 45 years, it is only in relatively recent times that authors have begun to focus on the factors that influence how investors behave when assessing new information and in particular, whether they react differently to good and bad news. Williams (2009) demonstrated that the prevailing level of uncertainty impacts on how investors respond to earnings announcements, Kim et al. (2010) found similarly when studying the market response to the release of management forecasts, and Bird et al. (2013) extended the analysis to examine how uncertainty influences the post-earnings announcement drift.

The motivation for this study is to investigate whether *firm specific characteristics influence the behaviour of investors when reacting to earnings news* especially once account is taken of the effect of market uncertainty. This is an important issue, especially because of the insights that it could provide into the anomalous behaviour of stocks at the time of information release. First, we establish a base case by examining the impact that market uncertainty has on the process by which investors assimilate earnings news into prices. We then extend this base case to determine whether there are particular firm-specific factors that also impact on how investors respond and particularly how these factors interact with market uncertainty. We find evidence of several factors, including

valuation, idiosyncratic risk, size, financial leverage, trading volume and industry that play a role in determining the extent of investor reaction at the time of the release of new information.

The remainder of the paper is structured as follows. Section 2 provides background information on the literature relating to the factors that are likely to impact on how investors react to information signals, with special concentration on uncertainty. Section 3 presents data and research methods that we employ. Our findings are reported and discussed in Section 4 and Section 5 provides summary of our findings.

2 Background

It is well recognised in the markets that uncertainty has an important effect on investor behaviour. This phenomenon is captured by Gross (2011), who states:

> "It's a truism that equity markets hate uncertainty …. When bad things happen, or when investors think bad things are going to happen, they sell stocks. When anxiety fades, they buy stocks."[1]

Our intention is to examine how this description of investor behaviour translates into their reaction to new information conditioned on the prevailing level of market uncertainty existing at the time of the information release. In this paper we:

- examine the generality of the finding that uncertainty always results in an asymmetric response to the release of good and bad information (Williams, 2009).
- demonstrate that various firm characteristics play an important role in determining how investors react to information signals after taking into account the overriding effect that uncertainty has on their reaction.

2.1 Uncertainty and decision making

Standard economic models only account for risk and so fail to provide us with any insights as to how investors faced with uncertainty will react to new information.[2] The main difference being that in an uncertain world no one can derive a unique subjective probability distribution to describe the outcome of one's decisions. With uncertainty, there are a whole series of such distributions with no certainty as to which one will applies. The usual method to deal with an uncertain world where everything is indeterminate is to make simplifying assumption about the behaviour of decision makers that allows one to collapse an uncertain situation into a risky situation.

Gilboa and Schmeidler (1989) assumed that investors faced with uncertainty base their decisions on maxmin expected utility (MEU). The intent of this assumption is that investors faced with multiple priors will take a pessimistic stance and choose the option which they expect to maximise their utility under the worst possible outcome. Epstein and Schneider (2008) demonstrated that investors who follow MEU when faced with certainly will want to be compensated for uncertainty (i.e., they are uncertainty-averse as they are risk-averse). They report that in situations of uncertainty, investors react asymmetrically to information: over-weighting bad news and under-weighting good news (Caskey, 2009).[3]

Only a handful of studies have examined the differential impact that good and bad news might have on investor behaviour (Berens, 2010). Freeman and Tse (1992) were the first to highlight the fact that there is a non-linear response between unexpected earnings and unexpected returns. Conrad et al. (2002), following models developed by Barberis et al. (1998) and Veronesi (1999) show that the magnitude of the market reaction to bad news increases with the strength of the market as does the difference in the response to bad and good news. Francis et al. (2007) argue that investors underreact to all information signals where they are uncertain as to the credibility of the information and then, subsequently adjust their expectations when this uncertainty is resolved. Williams (2009) was the first to establish the link between the level of uncertainty in the market and the greater market response to 'bad news' earnings announcements relative to the response to 'good news' earnings announcements. The asymmetric response identified by Williams was confirmed by Kim et al. (2014) when he examined the market response to the release of earnings forecasts by management. Bird and Yeung (2012) also found that the market reacted much more strongly to bad news than to good news when it was released at a time when market uncertainty is high. However, they found that this asymmetric response reversed when the earnings information is released during a period of low market uncertainty.

In addition to providing new evidence on how market uncertainty impacts on how investors react to information signals, we are particularly interested in identifying other factors that have potential to explain cross-sectional variation in investor's reaction. In particular, prior research has identified numerous firm-specific factors that have potential to impact valuation, such as stock beta,[4] book-to-market and size (Fama and French, 1992). We evaluate the impact of these factors as well as numerous others stock characteristics including trading volume, stock liquidity and industry which may also have an impact on investor reaction to information signal.

3 Research question, data and methodology

Our focus in this paper is on extending previous analysis of the impact that market uncertainty has on the decision processes of investors. There have been several recent empirical papers that have shown that investors become more pessimistic as uncertainty grows which results in them underweighting good news and overweighting bad news (Williams, 2009; Bird and Yeung, 2012). Although this result may hold on average across all information releases, the question we attempt to address is the extent of its generality.

3.1 Data

Our sample consists of the returns on US equities over the period from January 1986 to September 2009. We use four types of data: data from the equity market, data from the options market, accounting data, and analysts' forecasts. The return data from the equity market are obtained from CRSP through WRDS. Our measure of market uncertainty is the implied volatility index (or VIX) from CBOE.[5] The accounting data which includes reported earnings is obtained from the CRSP/COMPUTSTAT merged database which is sourced through WRDS. Finally, the analysts' forecasts are obtained from I/B/E/S through WRDS.

Our final sample set consisted of 112,432 observations of quarterly earnings announcements. To be included in the final sample, we require the firms to have earnings announcements in at least each of the previous five quarters. We also require information on firm characteristics (such as book-to-market and firm size), analysts' earnings forecasts, VIX and company returns at the time of the earnings announcements. Consistent with standard practice, we reduce the impact of outliers by trimming firm characteristics at the 1 and 99th percentile.

In the following section, we provide a brief discussion on the calculation of the two major variables, unexpected earnings and market uncertainty, used in this study and then we outline measures that we use to reflect several firm-specific characteristics.

3.2 Unexpected earnings

Our study revolves around evaluating the stocks returns in the period after the release of a 'good' or 'bad' earnings announcement. Good (Bad) is defined as where the unexpected component of the earnings announcement is positive (negative). We measure this unexpected component as the difference between the actual EPS and analysts' consensus earnings estimate in the month immediately prior to the announcement (Han and Wild, 1990; Francis et al., 2007). Consistent with the literature, we scaled the unexpected earnings by the absolute value of reported EPS to arrive at our final measure of unexpected earnings.[6] So the scaled unexpected earnings measure is as follows:

$$UE_i = \frac{Actual\ EPS_i - Consensus\ EPS\ Estimate_i}{Actual\ EPS_i}.$$

A positive unexpected earnings (PUE) event occurs when the earnings just announced exceeds expected earnings. Similarly, a negative unexpected earnings (NUE) event occurs when the earnings just announced falls short of expected earnings.

3.3 Uncertainty

Uncertainty in the context that we are considering relates to how investors interpret the implications of a particular piece of information. This has been modelled in a number of ways with some using the quality of information emanating from a firm as indicated by its use of accruals to proxy for uncertainty (Francis et al., 2007) while others use disagreement among analysts as to the expected earnings of a particular stock as a measure of the difficulty that market participants had in interpreting the implications of the information (Barron et al., 1998; Zhang, 2006). However, all of these proxies are designed to measure uncertainty at the firm level whereas we require a market-wide measure of uncertainty. Anderson et al. (2009) obtained such a measure by aggregating the analysts' earnings forecasts for all firms and used the dispersions in these aggregated forecasts as a quarterly macro-measure of uncertainty. The problem is that the Anderson measure cannot be calculated on the daily basis as required in this study.[7]

We have chosen to measure uncertainty by the implied volatility from the options market (VIX) as used by Williams (2009), Drechsler (2009), Kim et al. (2010), Bird and Yeung (2012). By using the VIX, we have a measure that is available on a daily basis which is also forward-looking, and capturing the very uncertainty that

investors perceive as they receive news and attempt to interpret and act on this new information.

Although some critics have suggested that VIX provides an estimate of risk (i.e., volatility) rather than uncertainty, we would draw support from several suggest recent studies that suggest otherwise. A number of studies have found that the option generated implied volatility is too large to be a reasonable forecast of the future returns variance (Eraker, 2004; Carr and Wu, 2009). Moreover Drechsler (2009) provided further support for VIX through a general equilibrium model that incorporated time-varying Knightian uncertainty. This model is able to explain the large hedging/variance premium that is evidenced in the markets. Drechsler argued that the large time-varying option premium (which is reflected in the implied volatility) is consistent with investors using options for protection against uncertainty (and time-variation in uncertainty). To support his view, Drechsler showed through calibration that fluctuations in the variance premium reflect changes in the level of uncertainty. We would suggest that on balance, VIX provides a more than reasonable proxy for uncertainty especially in the context of this study where our focus is on the investors reactions in highly uncertain times.

3.4 Stock-specific characteristics

The main focus of our paper is to study the impact of several stock-specific characteristics on how the market responds to the release of earnings news. The characteristics that we have chosen to examine were selected on the basis that they have been found to be correlated with stock returns. The inference being they represent factors that investors consider when evaluating stocks and so may well impact on how they react to information signals. These characteristics are briefly discussed below:

Value/growth: Our objective is to examine whether the typical investor disinterest in value stocks feeds through to how investors react to information emanating from growth and value firms (Lakonishok et al., 1994). The measure that we use for growth/value is the stock's book-to-market ratio with stocks being ranked by this valuation multiple and, as with each of the other characteristics, divided into two groups: those above the median being classified as value stocks and those below the median as growth stocks.

Large/small: Small cap stocks are commonly regarded as more risky and less researched than large cap stocks, both of which may impact on the way that investors' react to information. We rank stocks on the basis of their total assets and then divide them into two groups in a similar way to that described above for value and growth stocks.

Risk: Risk plays a central role in valuations and we investigate the extent to which this flows through to how investors react to information (Fama and French, 1992). We investigate the impact of a stock's total risk as measured by the standard deviation of its returns measured over the 20 days prior to the earnings announcement window.

Financial risk: One component of a stock's overall risk is its financial risk and we also investigate its impact on how investors react to information signals. In this study we investigate how financial risk impacts on the market response to an information release measuring financial risk by the financial leverage of the company. Financial leverage is calculated as the sum of the short term debt and long term debt divided by the total assets of the company.

Liquidity: Liquidity has been shown to play an important role in determining stock prices so it might be expected to play a role in determining how a stock reacts to information signals. In this study we use as the liquidity measure, the abnormal returns over the three-day announcement period ($t-1$, t and $t+1$) divided by its average trading volume over the 29 trading days prior to the announcement.

Trading volume: A number of studies have found a relationship between abnormal trading volume and market uncertainty which we further investigate in this study (Blume et al., 1994). We measure abnormal volume by dividing the average daily volume over the announcement period by the average daily volume over the previous 26 trading days.

Industry sector: In our sample, there is a wide variation in the nature of industry sectors ranging from the relatively low risk utilities to the much more volatile information technology. We divide the firms up into 10 industries based on their Level 2 GICS classifications.

3.5 Methodology

Our basic model is designed to identify how the market reacts to the release of earnings announcements by companies as follows:

$$R_{ip} = \beta_o + \beta_1 \text{NUE}_{it} + \beta_2 \text{PUE}_{it} + \beta_3 \log(\text{MV}_{it}) + \text{Year Effects} + \varepsilon_{it} \quad (1)$$

where: R_{ip} = the accumulated excess return[8] over the announcement period which covers a three-day period commencing on the day before, and ending on the day after the announcement (i.e., $t-1$ to $t+1$).

NUE = UE if UE < 0; else NUE = 0

PUE = UE if UE > 0; else PUE = 0

MV_{it} = the market capitalisation of firm i at the announcement day, t

Yearly fixed effects are included in the regression

We next test the extent to which the market response is affected by the prevailing level of uncertainty. Our measure of uncertainty takes account of both the level of VIX immediately prior to the release of the information (i.e., at $t-2$) and the change in the level of VIX over the announcement period ($t-1$ to $t+1$). We include both of these variables in an expanded version of equation (1) which becomes our base case for all subsequent analysis conducted in this paper:

$$\begin{aligned} R_{ip} = {} & \beta_o + \beta_1 \text{NUE}_{it} + \beta_2 \text{PUE}_{it} + \beta_3 D_1 \text{NUE}_{it} + \beta_4 D_1 \text{PUE}_{it} + \beta_5 D_2 \text{NUE}_{it} \\ & + \beta_6 D_2 \text{PUE}_{it} + \beta_7 D_3 \text{NUE}_{it} + \beta_8 D_3 \text{PUE}_{it} + \beta_9 \log(\text{MV}_{it}) + \text{Year Effects} + \varepsilon_{it} \end{aligned} \quad (2)$$

where

$D_1 = 1$, where the level of VIX of firm i at $t-2$ is above its median value over our entire sample; otherwise $D_1 = 0$.

$D_2 = 1$, where ΔVIX is in the 2nd tercile when all ΔVIX in our sample are sorted; otherwise $D_2 = 0$.

$D_3 = 1$, where ΔVIX is in the 3rd tercile when all ΔVIX in our sample are sorted; otherwise $D_3 = 0$.

We further expand our analysis to incorporate the other stock and characteristics discussed in the previous section. We do this by expanding equation (2) to incorporate each of these factors by introducing them sequentially into the following equation:

$$\begin{aligned} R_{ip} = {} & \beta_0 + \beta_1 \mathrm{NUE}_{it} + \beta_2 \mathrm{PUE}_{it} + \beta_3 D_1 \mathrm{NUE}_{it} + \beta_4 D_1 \mathrm{PUE}_{it} \\ & + \beta_5 D_2 \mathrm{NUE}_{it} + \beta_6 D_2 \mathrm{PUE}_{it} + \beta_7 D_3 \mathrm{NUE}_{it} + \beta_8 D_3 \mathrm{PUE}_{it} \\ & + \beta_9 D_4 \mathrm{NUE}_{it} + \beta_{10} D_4 \mathrm{PUE}_{it} + \beta_{11} \log(\mathrm{MV}_{it}) + \text{Year Effects} + \varepsilon_{it} \end{aligned} \tag{3}$$

where $D_4 = 1$, if the value of the factor (e.g., the stock's beta) is above the median just prior to the announcement (i.e., at the end of $t - 2$); otherwise $D_4 = 0$.

4 Discussion of our findings

4.1 Base case

Panel A of Table 1 reports the results for equation (1) relating to investors' response to good and bad news. Our results indicate that there is a significant market reaction over the announcement period to the release of the unexpected component of the earnings number but that the extent of the reaction is greater for good news than for bad news. Our findings are consistent with view that the market on average has a slight optimistic bias, which contrasts with the pessimistic bias one might expect if investors consistently followed MEU.

Panel B of Table 1 reports the results for equation (2) which determines whether the optimistic bias reported in panel A is maintained across the whole spectrum of uncertainty.[9] Our results confirm that there is an optimistic bias when the information is released at a time when uncertainty is low (i.e., reaction to PUE is greater than the reaction to NUE) but that this turns to a pessimistic bias when the information is released at a time when uncertainty is high. This finding is at variance with the proposition of Williams (2009) that investors will act in a way consistent with MEU across the whole uncertainty spectrum and hence always exhibit a pessimistic bias when it comes to evaluating information.

Our findings also run contrary to much of the conceptual work dealing with uncertainty. For example, Epstein and Schneider (2008) demonstrate that investors are averse to uncertainty in a similar way to that they are averse to risk. This would suggest a negative relationship between uncertainty and the market reaction to information (i.e., greater reaction to bad news than good news) across that whole uncertainty spectrum. Our evidence confirms that uncertainty plays an important role in determining how investors react to information signals but that the direction of this relationship is only negative when uncertainty is high and changes to being positive when uncertainty is low. In a similar vein to Schroder (2007) suggests that investors deviate from applying MEU when uncertainty is low, actually switching to taking an optimistic stance and basing their decisions on the more optimistic amongst the range of the uncertain outcomes that confront them. Such behaviour implies that even under an uncertain climate, the presence of overconfident investors could result in the development of price bubbles which seem precluded in a model where investor behaviour is always described by MEU.

Table 1 Market reaction: uncertainty

Panel A: Market reaction to good and bad news				
NUE		*PUE*		*Significance test*
0.0145***		0.0163***		P > N***
Panel B: Market reaction under low and high uncertainty				
		NUE	*PUE*	*Significance tests*
Uncertainty	Low	0.0144***	0.0199***	P > N***
	High	0.0157***	0.0120***	N > P***
Significance tests		H > L***	L > H***	

*, ** and *** denotes statistical significance at the 10%, 5% and 1% level respectively.

In panel A of the above table reported the basic results for the basic regression (or equation (1)):

$$R_{ip} = \beta_o + \beta_1 \text{NUE}_{it} + \beta_2 \text{PUE}_{it} + \beta_3 \log(\text{MV}_{it}) + \text{Year Effects} + \varepsilon_{it}. \quad (1)$$

Unexpected earnings (UE) are defined as the difference between the actual earnings and the consensus earnings estimate in the month immediately prior to the earnings announcement. PUE = UE when UE is >0, otherwise PUE = 0. Similarly NUE = UE when UE is <0, otherwise NUE = 0. The log of market capitalisation, $\log(\text{MV}_{it})$, and fixed yearly effects have been included as control variables.

In Panel B, we reported the basic results for the basic regression (or equation (2)):

$$R_{ip} = \beta_o + \beta_1 \text{NUE}_{it} + \beta_2 \text{PUE}_{it} + \beta_3 D_1 \text{NUE}_{it} + \beta_4 D_1 \text{PUE}_{it} + \beta_5 D_2 \text{NUE}_{it} + \beta_6 D_2 \text{PUE}_{it} + \beta_7 D_3 \text{NUE}_{it} + \beta_8 D_3 \text{PUE}_{it} + \beta_9 \log(\text{MV}_{it}) + \text{Year Effects} + \varepsilon_{it}. \quad (2)$$

For equation (2), a number of interaction variables are used to ascertain the effect of the degree of uncertainty on the investors' reaction to earnings announcements. $D_1 = 1$, where the level of VIX of firm i at $t - 2$ is above its median value over our entire sample; otherwise $D_1 = 0$. $D_2 = 1$ where ΔVIX is in the 2nd tercile when all ΔVIX in our sample are sorted; otherwise $D_2 = 0$. $D_3 = 1$ where ΔVIX is in the 3rd tercile when all ΔVIX in our sample are sorted; otherwise $D_3 = 0$. We defined low uncertainty as times where VIX is in the bottom tercile and high uncertainty as times when the announcement occurs when VIX is in the top tercile. We run Wald tests of differences on the coefficients to compare the reaction to positive and negative earnings surprise under high and low uncertainty.

4.2 Impact on stock characteristics on investor reaction

The third stage in our analysis is to evaluate the impact of the several firm characteristics listed previously, conditioned by the prevailing level of market uncertainty, on how investors react to earnings announcements. In each case, we make use of an indicator variable to segregate the sample up in accordance with the particular characteristic (e.g., value/growth, large/small) and then effectively apply the same analysis as in our base case (equation (1)). Our findings are reported in Table 2 and discussed below.

4.3 Value/growth

Our findings with respect to value and growth stocks as reported in Panel A of Table 2 demonstrate that the reaction of both types of stocks to bad news is very similar and independent of the level of market uncertainty prevailing at the time of the

earnings announcement (Skinner and Sloan, 2002; Bird et al., 2005).[10] In contrast, investors react much more strongly to good news announcements emanating from growth stocks than they do to the same good news emanating from value stocks. Further, the market reaction to good news is always greater when the good news is realised at a time when market uncertainty is low. Finally, we see that for growth stocks there is a much greater market reaction to good news than bad news at times of low market uncertainty where as for value stocks there are a much greater market reaction to bad news than good news at times when market uncertainty is high. These findings are very much in line with investors being more optimistic when evaluating growth stocks than they are when evaluating value stocks and confirm that the market's perception of a company plays an important role in determining how investors reacts to an information release by a company.

4.4 Small/large firms

Since the identification of the size effect by Banz (1981) it has become accepted that small capitalisation stocks generate higher returns than large firms because they are inherently more risky. The question is whether investors also places less credibility on information provided by smaller firms and so react to it in a different way to the same information issued by larger firms. We again used equation (3) to condition our findings on small and large firms and our results are reported in Panel B of Table 2. Our results are somewhat analogous to those for growth/value stocks with this time investors displaying optimism as evidenced by investor reaction to earnings announcements released by larger companies and the somewhat expected pessimism when reacting to these announcements by smaller companies. With respect to good news announcements, there is a slightly greater positive (but not significant) reaction in the case of larger companies while the reaction in the case of both larger and smaller stocks is much greater when the good news is released when market uncertainty is low. This all changes when we examine the reaction to bad news announcements as now the consequential downward market adjustment is much greater in the case of smaller companies but with the level of market uncertainty having little impact on the extent of the markets initial reaction to bad news. Finally, we find that there is a much greater reaction to bad news issued by small companies at a time when market uncertainty is high whereas there is a much greater reaction to good news emanating from larger companies at a time when market uncertainty is low. These findings all aggregate to suggest that investors take a more positive attitude to evaluating the earnings announcements of larger companies than they do when evaluating the earnings announcements of smaller companies.

4.5 Total risk

It is well established that investors are averse to risk and many writers suggest that they have a similar aversion to uncertainty. In order to investigate the interplay between the two, we examine the combined impact of total risk (or idiosyncratic risk) and uncertainty on how investors react to new information.[11] We again use equation (3) with this time the observations divided on the basis of whether the stock's total risk is above- or below-median. The results as reported in Panel C of Table 2 indicate that the extent of

the market's reaction to both good news and bad news are influenced by the idiosyncratic risk of the stock. Irrespective of whether the news was good or bad, investors reacted much more to unexpected earnings announcements made by firms with high idiosyncratic risks than they did to similar announcements made by firms with low idiosyncratic risk. This result is at variance with that of Doukas and Li (2008), Rachwalski and Wen (2013) who both found that investors tend to under-react to news released by firms with high idiosyncratic risks. Further we found that the introduction of idiosyncratic risk did not change our previous finding that the investors tend to take an optimistic stance when information is released at a time when market uncertainty is low but that this switches to taking on a pessimistic stance when the news is released at a time when market uncertainty is high. Again this finding is at variance with the notion that investors when faced with uncertainty, investors behave as though they are maximising their utility under the worst possible outcome (i.e. investors do not consistently follow a maxmin utility approach).

4.6 Financial risk

Next, we examine whether the level of financial risk in a business impacts on how investors react to information under uncertainty. The results of the analysis are reported in Panel D of Table 2. We find that the level of financial leverage plays an important role in conditioning the extent of any investor response to the release of information. Our results suggest that investors exhibit a greater reaction to both good and bad news in the case of firms with low financial leverage. This finding is consistent with Moradi et al. (2010) who also found that low leverage firms exhibit a greater response to earning news than do high leverage firms. Our findings also highlight that irrespective of a firm's financial leverage, the reaction to bad news is always greater than the response to good news, when the information is released at a time when market uncertainty is high. In contrast, we find that when uncertainty is low, the market response to good news is likely to be greater that it is to bad news.

4.7 Liquidity

There is now a large amount of evidence to suggest that investors require greater compensation to hold illiquid stocks (Pastor and Stambaugh, 2003). In order to further investigate the impact that illiquidity has on how investors react to information, we divide our sample on the basis of our liquidity measure and our findings are reported in Panel E of Table 2. Our findings that the market reaction to earnings announcements by the less liquid stocks is much more volatile with these stocks falling most after a bad news announcement and rising most after a good news announcement. Another interesting finding is that the level of uncertainty prevailing at the time of the earnings announcements has no impact on the magnitude of the reaction to bad news irrespective of the liquidity of the stock whereas for good news there is a much greater upward adjustment when the level of uncertainty is low. Finally, there is a much greater upward reaction to good news than bad news when uncertainty is low but this largely reverses when uncertainty is high. The findings are somewhat analogous with those previously discussed for total risk with the response of stocks with low liquidity to earnings announcements being much more volatile as was the case with stocks with high total risk.

4.8 Abnormal trading volume

Dow and Werlang (1992) following a MEU framework show that uncertainty creates a wedge between buyers and sellers in the market and so reduces the incentives for market participation. Epstein and Schneider (2003) confirm that an increase in uncertainty causes investors to abstain trading but that this will reverse when the uncertainty is resolved. Using our measure of abnormal trading volume we evaluated the impact that trading volume would have on how investors react to information and our findings are reported in Panel F of Table 2.[12] Our findings highlight the huge differential between the market reaction to information signals during periods of abnormally high and abnormally low trading volume. When trading is abnormally high, there is a very large market reaction to bad and an even higher market reaction to good news. The market reaction to the release of earnings announcements is much more muted when it is associated with below-normal trading activity with there being no market response to good news when there is both low market activity and high market uncertainty. Overall, our findings suggest that the level of abnormal trading volume around the time of the earnings announcement appears as important, if not even more important than, market uncertainty in providing an explanation for the asymmetric market reaction to the release of earnings information.[13]

Table 2 Market reaction: uncertainty and stock characteristics

		NUE		*PUE*		*Significance tests*	
		Uncertainty		*Uncertainty*		*Uncertainty*	
		Low	*High*	*Low*	*High*	*Low*	*High*
Panel A: Market reaction: uncertainty and valuation							
Book-to-market	Growth	0.0148***	0.0160***	0.0220***	0.0146***	P > N***	n.s.
	Value	0.0145***	0.0158***	0.0165***	0.0091***	n.s.	N > P***
Significance tests		n.s.	n.s.	G > V***	G > V***		
Panel B: Market reaction: market reaction: uncertainty and size							
Total assets	Small	0.0161***	0.0174***	0.0183***	0.0104***	n.s.	N > P***
	Large	0.0123***	0.0137***	0.0200***	0.0121***	P > N***	n.s.
Significance tests		S > L**	S > L**	n.s.	n.s.		
Panel C: Market reaction: uncertainty and risk							
Standard deviation (σ)	Low	0.0097***	0.0104***	0.0141***	0.0048***	P > N***	N > P***
	High	0.0176***	0.0183***	0.0229***	0.0135***	P > N***	N > P***
Significance tests		H > L***	H > L***	H > L***	H > L***		
Panel D: Market reaction: uncertainty and financial risk							
Financial leverage	Low	0.0171***	0.0185***	0.0214***	0.0132***	P > N**	N > P***
	High	0.0129***	0.0142***	0.0155***	0.0073***	n.s.	N > P***
Significance tests		L > H***	L > H***	L > H***	L > H***		
Panel E: Market reaction: uncertainty and liquidity							
Liquidity	Low	0.0198***	0.0205***	0.0304***	0.0217***	P > N***	n.s.
	High	0.0051***	0.0058***	0.0087***	0	P > N**	N > P***
Significance tests		L > H***	L > H***	L > H***	L > H***		

Table 2 Market reaction: uncertainty and stock characteristics (continued)

		NUE		*PUE*		*Significance tests*	
		Uncertainty		*Uncertainty*		*Uncertainty*	
		Low	*High*	*Low*	*High*	*Low*	*High*
Panel F: Market reaction: uncertainty and abnormal trading volume							
Abnormal trading volume	Low	0.0093***	0.0112***	0.0033**	–0.0013	N > P***	N > P***
	High	0.0212***	0.0231***	0.0379***	0.0332***	P > N***	P > N***
Significance tests		H > L***	H > L***	H > L***	H > L***		

*, ** and *** denotes statistical significance at the 10%, 5% and 1% level, respectively.

The table reports the regression results of equation (3):

$$R_{ip} = \beta_o + \beta_1 \text{NUE}_{it} + \beta_2 \text{PUE}_{it} + \beta_3 D_1 \text{NUE}_{it} + \beta_4 D_1 \text{PUE}_{it} + \beta_5 D_2 \text{NUE}_{it} + \beta_6 D_2 \text{PUE}_{it} + \beta_7 D_3 \text{NUE}_{it} + \beta_8 D_3 \text{PUE}_{it} + \beta_9 D_4 \text{NUE}_{it} + \beta_{10} D_4 \text{PUE}_{it} + \beta_{11} \log(\text{MV}_{it}) + \text{Year Effects} + \varepsilon_{it}. \quad (3)$$

Unexpected earnings (UE) are defined as the difference between the actual earnings and the consensus earnings estimate in the month immediately prior to the earnings announcement. PUE = UE when UE is >0, otherwise PUE = 0. Similarly NUE = UE when UE is <0, otherwise NUE = 0. $D_1 = 1$, where the level of VIX of firm i at $t - 2$ is above its median value over our entire sample; otherwise $D_1 = 0$. $D_2 = 1$ where ΔVIX is in the 2nd tercile when all ΔVIX in our sample are sorted; otherwise $D_2 = 0$. $D_3 = 1$, where ΔVIX is in the 3rd tercile when all ΔVIX in our sample are sorted; otherwise $D_3 = 0$. In each panel of the above table (Panel A to Panel E), we included in our analysis two interaction variables. These interaction variables allow us to detect any cross sectional differences in investors' reaction for firms of various characteristics. In panel A, we evaluate how company valuation (as measured by the book to market ratio) impact on the reaction to earnings announcement. We measure the Book to Market ratio just prior to the announcement (i.e., at the end of $t - 2$). D_4 is equal to 1 if the book to market is above the median just prior to the announcement (i.e., at the end of $t - 2$); otherwise $D_4 = 0$. In Panel B, we incorporate Total Assets as the measure for firm size. D_4 is a dummy variable for stocks with high total assets. D_4 is equal to 1 if the firm size is above the median just prior to the announcement (i.e., at the end of $t - 2$); otherwise $D_4 = 0$. In Panel C and Panel D, we incorporate into our analysis two measures of risks: namely standard deviation of stock returns and financial risks. Total risk as measured by the standard deviation of its returns measured over the 20 days prior to the earnings announcement date. Financial risk is measured by the financial leverage of the company which is calculate as the sum of short term and long term debt of the company divided by the Total Assets. In Panel E, we examine the market reaction of firms whose stocks have differing level of liquidity. Liquidity is the ratio of abnormal returns for announcement period $\{t - 1, t + 1\}$ to the average trading volume in the 30 day period prior to the announcement (i.e., $t - 30$ to $t - 2$). These variables are included in the regression through the dummy variable D_4. $D_4 = 1$, if the value of the factor (e.g., the stock's beta) is above the median just prior to the announcement (i.e., at the end of $t - 2$); otherwise $D_4 = 0$. In Panel F, we incorporate into our analysis a measure of abnormal volume, AbVol which is calculated as the average daily trading volume for stock i over the announcement period divided by the average trading volume of stock i over the previous 29 trading days. We sort the abnormal volume parameter across the entire sample to form a new indicator variable (D_4 in our equation). High trading volume is where AbVol is greater than 1 (i.e., $D_4 = 1$). When AbVol is less than 1 (i.e., low trading volume), D_4 is equal to 0.

4.9 Impact of industry classification on investor reaction

The final proposition that we examine is whether a firm's line of business has an influence on how its stock reacts to information signals. In order to evaluate this we divided the sample into 10 industry categories, based on the Level 2 GICS classification with our findings being reported in Table 3. From our previous discussion, we have designated our base case as being a significantly greater reaction to good news than bad news when uncertainty is low which reverses when uncertainty is high. The only industry that strictly adheres to this pattern is information technology. The other nine industries conveniently fall into one of two groups. Those where there is a greater response to good news than bad news when uncertainty is low but an equal reaction to each when uncertainty is low, which represents an *optimistic* bias relative to the base case. The four industries that fall into this category are industrials, consumer discretionary, consumer staples and financials. The other group is characterised by a greater reaction to bad news than good news when uncertainty is high with an equal reaction to each when uncertainty is low, which represents a pessimistic bias. The five industries that fall in this group are energy, materials, health care, services and utilities.

Table 3 Market reaction: uncertainty and industry classification

	NUE		*PUE*		*Significance tests*	
	Uncertainty		*Uncertainty*		*Uncertainty*	
Industry	*Low*	*High*	*Low*	*High*	*Low*	*High*
Energy	0.0094***	0.0078***	0.0130***	0.0052***	n.s.	N>P**
Material	0.0147***	0.0131***	0.0179***	0.0101***	n.s.	N>P**
Industrials	0.0142***	0.0126***	0.0262***	0.0184***	P>N***	n.s.
Consumer disc.	0.0128***	0.0112***	0.0214***	0.0136***	P>N***	n.s.
Consumer staples	0.0143***	0.0128***	0.0301***	0.0223***	P>N***	P>N*
Health care	0.0181***	0.0165***	0.0163***	0.0085***	n.s.	N>P***
Financials	0.0113***	0.0097***	0.0173***	0.0095***	P>N**	n.s.
Info. technology	0.0178***	0.0162***	0.0213***	0.0135***	P>N**	N>P**
Services	0.0137***	0.0121***	0.0154***	0.0076	n.s.	N>P
Utilities	0.0102***	0.0087***	0.0097**	0.0019	n.s.	N>P***

*, ** and *** denotes statistical significance at the 10%, 5% and 1% level respectively.

In Table 3, we consider the proposition that the market reaction to good and bad news may be dependent on the line of business that a company operates. In order to evaluate this, we classified the sample of announcements in to 10 broad industry sectors according to the Level 2 global industry classification standard (GICS). We modified equation (3) to include dummy variables that indicate the industry to which the firm making the announcement belongs. The regression results are reported in the above table. For ease of interpretation, we have formatted the above table to show only the main results for the coefficients on the PUE and NUE variables.

We next attempt to explain the optimistic and pessimistic biases attached to the various industries using factors that we identified previously in the paper as being associated with investors taking either a pessimistic or optimistic stance. We calculated the average value across our sample for three of these factors by sector in order

to see whether they provide us with any insights into what is driving the different findings across industries. Our findings as reported in Table 4 suggest that these factors explain very little of the variation across industries. There is very weak evidence that higher total risk is more associated with investors taking a more pessimistic view when evaluating information signals. It is worth noting that this relationship is much stronger when we substitute beta for total risk when attempting to explain investor response industries.[14] There is only weak alignment between high market capitalisation and the investor optimism that we have identified and even weaker alignment in the case of book-to-market.

Table 4 Industry characteristics

Industry	*Optimism/pessimism*	*Book-to-market*	*Market cap* ($'M)	*Total risk*
Energy	Pessimistic	0.649	2713.39	0.026
Material	Pessimistic	0.771	2174.10	0.025
Industrials	Optimistic	0.664	1466.67	0.028
Consumer disc.	Optimistic	0.736	1588.60	0.030
Consumer staples	Optimistic	0.598	3314.92	0.024
Health care	Pessimistic	0.426	1431.32	0.035
Financials	Optimistic	0.714	2003.75	0.021
Info. technology	Neutral	0.573	1127.98	0.041
Services	Pessimistic	0.755	5300.58	0.034
Utilities	Pessimistic	0.925	3011.91	0.015

We have reported the mean characteristics (Book To Market, Market Capitalisation and Beta) of firms in the 10 GICS industrial sectors. Based on the coefficients and significance tests in Table 11, we classified each industry into 'pessimistic', 'optimistic' and 'neutral'. An industry is classified as 'pessimistic', if the coefficient for negative unexpected earnings (NUE) is greater than the coefficient for positive unexpected earnings (PUE). Put simply, there is a tendency for the market to react more to negative announcement than positive unexpected announcement in a 'pessimistic' industry. Similarly, an industry is classified as 'optimistic', if the coefficient for positive unexpected earnings (PUE) is greater than the coefficient for negative unexpected earnings (NUE). A 'neutral' industry is where there is no significant difference between the coefficients for NUE and PUE. Total risk as measured by the standard deviation of its returns measured over the 20 days prior to the earnings announcement date.

4.10 A multi-factor model

In our discussion to date we have identified that market uncertainty has an impact on how investors react at the time of an earnings announcements as do a number of stock characteristics when considered in concert with market uncertainty. In order to obtain an insight into the incremental contribution of each of these variables, we next run a multi-factor regression based on our base case (equation (2)) but also including all of the company characteristics other than industry classifications.

Table 5 Market reaction: multivariate risk factors analysis

		NUE	*PUE*	*Significance tests*
Panel A				
Uncertainty	Low	0.0067***	0.0110***	P > N***
	High	0.0079***	0.0035***	N > P***
Significance tests		H > L*	L > H***	
Panel B				
Size		0.0071***	0.0036***	N > P***
Book to market		0.0037***	0.0001	N > P***
Illiquidity		0.0025***	0.0022***	n.s.
Risk (standard deviation)		0.412***	0.186***	N > P***
Financial risks		–0.0022	0.0002	n.s.
Abnormal volume		0.0029***	0.0025***	N > P***

*, ** and *** denotes statistical significance at the 10%, 5% and 1% level respectively.

The table reports the regression results of an augmented version of equation where we included all the characteristics. We do so to obtain an insight into the incremental contribution of each of these variables, we run a multi-factor regression based on base equation (equation (2)) but also including all of the company characteristics other than industry classifications. The equation takes on the following form:

$$R_{ip} = \beta_o + \beta_1 \text{NUE}_{it} + \beta_2 \text{PUE}_{it} + \beta_3 D_1 \text{NUE}_{it} + \beta_4 D_1 \text{PUE}_{it} + \beta_5 D_2 \text{NUE}_{it} + \beta_6 D_2 \text{PUE}_{it} + \beta_7 D_3 \text{NUE}_{it} + \beta_8 D_3 \text{PUE}_{it} + \beta_9 \text{characteristics}_{it}\ \text{NUEDummy}_{it} + \beta_{10} \text{characteristics}_{it}\ \text{PUEDummy}_{it} + \ldots + \beta \log(\text{MV}_{it}) + \text{Year Effects} + \varepsilon_{it}.$$

We include 5 sets of characteristics interaction variables in to equation (2). The stock characteristics that we consider are size (as measured by Total Asset), book to market level, liquidity, risk (i.e., beta) and abnormal volume. Unlike the analysis in Table 2 where we made use of indicator variables and separated into distinct group (such as large and small) by their characteristics, we now use the use of the continuous measurement of these characteristic. We multiply each of these characteristics by the unexpected earnings dummy variables, NUEDummy and PUEDummy. PUEDummy = 1 when UE is >0, otherwise PUEDummy = 0. Similarly NUEDummy = –1 when UE is <0, otherwise NUEDummy = 0. Unlike the univariate analysis, where we focus on determining whether different types of firms (based on characteristics) possess differing degree of sensitivity to the level of unexpected earnings in various states of uncertainty. In this section, our interests lie in whether the investors' reaction to good news and bad news are directly proportional to the magnitude of a firm's characteristics. We measure the book to market ratio just prior to the announcement (i.e., at the end of $t-2$). Total Assets act as the measure for firm size. We incorporate into our analysis two measures of risks: namely total risks (i.e., standard deviation of stock returns) and financial risks. Total risk as measured by the standard deviation of its returns measured over the 20 days prior to the earnings announcement date. Financial risk is measured by the financial leverage of the company which is calculate as the sum of short term and long term debt of the company divided by the firm's Total Assets. Liquidity is the ratio of abnormal returns for announcement period $\{t-1, t+1\}$ to the average trading volume in the 30 day period prior to the announcement (i.e., $t-30$ to $t-2$). Finally the measure of abnormal volume, AbVol which is calculated as the average daily trading volume for stock i over the announcement period divided by the average trading volume of stock i over the previous 29 trading days.

Our findings reported in Panel A of Table 5 are the equivalent of those reported in Panel B of Table 1 where we first identified the impact that uncertainty has on the market's reaction to earnings announcements. We find that the impact of uncertainty remains unchanged after we introduce several stock characteristics as explanatory variables. We still see overwhelming evidence that the prevailing market uncertainty at the time that a company releases its earnings has a significant impact on how investors react to that information. We also continue to see that same asymmetric response to this information, with the reaction per quantum of information being greater when uncertainty is low but the reaction to bad news being greater when uncertainty is high. Further, the extent of the reaction to bad news is greater when uncertainty is high while in the case of good news, the reaction is greater when uncertainty is low.

In panel B of Table 5 we report the coefficients on each of the stock characteristic variables separated to measure their impact with respect to how investors react to both bad and good earnings announcements. Unlike the univariate analysis, where we focus on determining whether different types of firms (based on characteristics) possess differing degree of sensitivity to the level of unexpected earnings in various states of uncertainty. In this section, our interests lie in whether the investors' reaction to good news and bad news are directly proportional to the magnitude of a firm's characteristics. Put simply, we are examining the investors' sensitivity to these firm characteristic at times of good news and bad news announcements. The most important thing to note is that, consistent with our previous findings in a univariate setting, almost all of these characteristics have a significant impact on investor reaction. The notable exceptions being that the level of the book to market ratio which does not explain any of the market reaction to good news, and the level of financial leverage which does not seem to provide any explanation for the market reaction to either good or bad news. For all other characteristics, their impact on the market reaction to the information release is much greater for bad news than it is for good news. With respect to book-to-market, the investors in value stocks react more to bad news while as previously noted it does not impact on the reaction to good news. For size it is the larger stocks that react most to both good and bad news. In the case of liquidity, it is less liquid stocks that react most to both bad and good news which is the same result that we find for stocks that are enjoying relative high turnover. Panel B also show that more risky firms tend to exhibit a greater reaction to bad news than to good news.

5 Summary comments

The focus of this paper is on providing us with a better understanding as to how investors behave when reacting to information in a risky and uncertain environment. Williams (2009) using US data and Bird and Yeung (2012) using Australian both found that uncertainty influences investor reaction to information signals. However their findings differ in important ways in that Williams found that investor display a pessimistic bias across the whole uncertainty spectrum whereas Bird and Yeung found that they only displayed pessimism when uncertainty is high and actually took on an optimistic bias at time of low uncertainty. Using US data in this paper, we confirm the Bird and Yeung findings which are at variance with the typical asset pricing models which incorporate uncertainty by assuming that investors follow MEU and so always have an aversion to uncertainty.

Perhaps a more important contribution of this paper is that it highlights several stock-specific factors that in concert with uncertainty impact on how investors respond to information signals. For example, we find that investors tend to take a more pessimistic stance when evaluating information signals coming from small, value stocks. Further, we find that that there is much greater variability in the market reaction to good and bad news in the case of stocks with high idiosyncratic risk, low leverage less liquid stocks and stocks that experience abnormally high levels of trading at the time of the announcement. Finally we find that a company's industry classification influences the stance that investors take when evaluating its information signals with certain industries eliciting an optimistic response and others a pessimistic response.

The overall conclusion that we draw from our findings is that uncertainty provides an important role in determining how investors assess information but that this assessment is also conditioned by several stock-specific characteristics. Further, it seems that investors bring a state of mind when evaluating a stock which is impacted by several stock characteristics (e.g., in the case of large and low leveraged companies, investors are quite optimistic when evaluating good news but quite pessimistic when evaluating bad news). In summary, the factors that impact on how investors react to good and bad news are numerous with this paper providing an important step in improving our understanding of what is undoubtedly a very complex area.

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Notes

[1]Gross (2011) *Debt Deal Done: What Does It Mean?*, Appearing on the Yahoo website: http://finance.yahoo.com/blogs/daniel-gross/debt-deal-done-does-mean-063125258.html?sec =topStories&pos=main&asset=&ccode=

[2]If we follow a standard approach and assume that investors seek to maximise von Norman Neumann-Morgenstern utility and apply Bayes' rule when updating their expectations, then with log normal utility there will be an equal absolute reaction to the same modicum of good and bad news (i.e., no asymmetric reaction). Other forms of utility may lead to an asymmetric response but the exact form of this response cannot be predicted.

[3]Caskey (2009) demonstrated that under similar conditions uncertainty provided an explanation for many of the market anomalies such as momentum and the post-earnings announcement drift.

[4]Although we have investigated the impact that stock beta have on the investor reaction to news. We believe that a total risk measure is more appropriate measure of risk because our analysis is at the individual stocks level rather than portfolios of stocks.

[5]For a detailed explanation of the calculation of the VIX, see Williams (2009).

[6]We also tried several other measures of unexpected earnings including change in Return on Equity, change in earnings per share, the unscaled unexpected earnings and the unexpected earnings standardised by the standard deviation (SUE). All methods examined gave similar findings to those reported in this paper.

[7]Another problem with the uncertainty proxy used by Anderson et al. (2009) is that it can be affected by a number of other factors such as the heterogeneous beliefs of the analysts.

[8]The excess return is calculated on a daily basis as the difference between the daily return on a particular stock and that on the S&P500 index.

[9]We define low (high) uncertainty as an instance where VIX is decreasing (increasing) from an already low (high) base.

[10]This might be a surprising finding given the evidence to suggest that growth stocks dive when they release significant bad news (Skinner and Sloan, 2002). However, this is not so surprising when it is remembered that growth stocks will typically have strong momentum qualities and a number of papers have identified that the existence of momentum investors will delay the price impact of bad news (Bird et al., 2005).

[11]We also examined the impact of risk as measured by the stock's beta and found similar results.

[12]AbVol is calculated as the average daily trading volume over the announcement period divided by the average trading volume over the previous 29 trading days. High trading volume is where AbVol is greater than 1.

[13]Of course the chain of causation may be that it is the prevailing level of uncertainty at the time of the earnings announcement that determines the level of trading during the announcement period.

[14]The results for the analysis using systematic risks are not reported but are available on request from the authors.