Sentiment Effect on Analysts' Recommendations: Time-Series and Cross-Section Analyses

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Abstract

Previous empirical studies show that, in contrast to the classic economic theory, sentiment affects investors' decisions which, in turn, may affect market prices. The common hypothesis is that it is the unsophisticated investors, the "Noise Traders", who are mostly affected by sentiment. In this study, we show that a group of presumably highly sophisticated investors—financial analysts—are also affected by sentiment in a systematic way. Time-series analysis reveals that analysts' recommendations are positively correlated with Baker and Wurgler's (2006) comprehensive sentiment index. Cross-section analysis reveals that the sentiment effect on analysts' recommendations is generally more profound in stocks which are more difficult to evaluate: stocks of small, young, volatile, unprofitable, dividend non-payers, growing, and financially distressed firms. Consistent with the results in other studies, the significance level of the regression coefficients changes, conditional upon positive and negative sentiment, where in most cases the sentiment effect is more profound when sentiment is negative, in particular when the stock market is also bearish.

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1. Introduction

The two main tasks of equity financial analysts are macroeconomic analysis (asset allocation strategy), and individual firms' analysis (stock-picking). Two research topics regarding analysts' recommendations are widely covered in the financial literature: the economic value of analysts' recommendations and herding among analysts. In this study, we add a novel research dimension to the accumulated knowledge related to the analyst's work: the effect of sentiment on financial analysts' recommendations.

Regardless of the ability of analysts to predict future stock prices,[1] one tends to believe that the analyst's work is science rather than folklore; hence, non-economic factors like sentiment do not affect their recommendations. However, there is ample empirical evidence showing that analysts' recommendations are based not only on fundamental valuation models, but also on non-economic factors, which lends support to the hypothesis that analysts, like the less sophisticated investors, the "Noise Traders", are also affected by sentiment.[2]

Easterwood and Nutt (1999) find that analysts under-react to negative information and overreact to positive information. Based on a survey, Block (1999) reports an extremely low reliance of financial analysts on valuation methods in the formation of stock recommendations. Bradshaw (2004) finds that analysts do not appear to generate stock recommendations by using their own earnings forecasts, but

[1]Several studies suggest that analysts' recommendations contain substantial economic value. For example, Womack (1996) finds that changes in analysts' recommendations are associated with abnormal returns. Barber, Lehavy, McNichols, and Trueman (2001) find that trading, according to the most (least) favorable consensus recommendations, yields abnormal gross returns. Jagadeesh, Kim, Krische, and Lee (2004) find that the quarterly change in consensus recommendations is a robust predictor of future stock returns.

[2]The common explanation in the literature for the effect of sentiment on market prices is as follows:

1. Investor sentiment may irrationally affect investors' behavior and, in turn, affects prices. The common belief is that investors who are irrationally affected by sentiment are the relatively less sophisticated investors, also called the Noise Traders (see, e.g., De Long, Shleifer, Summers, and Waldmann 1990; and Shleifer and Summers 1990).

2. It is assumed that there are limits to arbitrage (see, e.g., Shleifer, and Vishny, 1997). Therefore, those sophisticated investors who are unaffected by sentiment cannot always take advantage (or can only partially take advantage) of the less sophisticated investors' irrational behavior; hence, sentiment affects market prices.

rather rely on valuation heuristics. Mola and Guidolin (2009) find that analysts are likely to assign frequent and favorable ratings to a stock after the analysts' affiliated mutual funds invest in that stock. Ljungqvist, Marston, Starks, Wei, and Yan (2007) find that analysts' recommendations, relative to consensus, are positively associated with investment banking relationships and brokerage pressure. This phenomenon occurs less in the presence of institutional investor owners. Similarly, Ertimur, Sunder, Sunder (2007), Barniv, Hope, Myring, and Thomas (2009) and Chen and Chen (2009) find that conflicts of interest from investment banking activities affect the accuracy and profitability of analysts' recommendations.

Additional evidence for financial analysts being affected by factors other than their own objective valuation models is the observed herding phenomenon among analysts. Trueman (1994) shows that analysts tend to release forecasts similar to those previously announced by other analysts, even when they are not justified by their information. Graham (1999) shows both theoretically and empirically that herding is more likely when an analyst has a high reputation or low ability, or if there is strong public information that is inconsistent with the analyst's private information. Welch (2000) shows that explicit buy and sell recommendations have a significant influence on the recommendations of the next two analysts' recommendations. Jegadeesh and Kim (2010) find that analysts from larger brokerages, analysts following stocks with smaller dispersion across recommendations, and analysts who make less frequent revisions are more likely to herd.[3]

In this study, we neither investigate the economic value of analysts' recommendations nor the herding phenomenon, topics which have been widely explored in the literature. We rather focus on the sentiment effect on analysts' recommendations which, in turn, may affect stock prices. Covering a period of almost

[3]It is worth mentioning that, after controlling for several factors, among them systematic optimism or pessimism among analysts, Bernhardt, Campello, and Kutsoati (2006) find that analysts "anti-herd". Namely, analysts systematically issue biased contrarian forecasts that overshoot the publicly-available consensus forecast in the direction of their private information.

20 years with about one million analysts' recommendations, we show that the presumably highly sophisticated investors—the financial analysts—are also affected by sentiment, making investment recommendations which are highly correlated with sentiment.

To claim that analysts' recommendations are correlated with market sentiment, and that the obtained correlation is not spurious, one must account for other factors that may induce this correlation. First, Baker and Wrugler's (2006) sentiment index, which we use as a proxy for sentiment, is constructed such that it is orthogonal to major economic variables. Naturally, analysts' recommendations are also affected by the condition of the economy. Indeed, we find that a substantial portion of the correlation between analysts' recommendations and sentiment is attributed to economic fundamentals. However, after accounting for several major economic variables, we find this correlation between analysts' recommendations and sentiment to remain highly significant, indicating that the found correlation is not spurious.

Second, during the studied period new regulations were imposed on analysts, which have induced some systematic changes in the recommendation practices. Nevertheless, we find that the correlation between analysts' recommendations and market sentiment is robust as regards these regulation changes, as it remains highly significant, even when considering sub-periods which are characterized by a relatively steady regulation regime.

Showing that analysts' recommendations are correlated with market sentiment, we next conduct a cross-section analysis to investigate what types of firm characteristics affect this correlation. Baker and Wurgler (2006, 2007) conducted an extensive cross-section analysis of the effect of investor sentiment on stock prices. They advocate and empirically document that the prices of stocks, which are more difficult to evaluate—and therefore more difficult to arbitrage and at the same time

more likely to be exposed to sentiment-based demands—are more likely to be affected by sentiment. Based on this theory, we also hypothesize that analysts' recommendations corresponding to stocks which are more difficult to evaluate are more likely to be affected by sentiment. In this case, the hypothesis asserts that when a stock is more difficult to evaluate the chances that the analyst's recommendation relies on non-economic factors, among them sentiment, increases.

Indeed, the empirical results of this study are generally consistent with this hypothesis. Recommendations corresponding to stocks of small, young, volatile, unprofitable, dividend non-payers, growing, and financially distressed firms are generally more affected by sentiment. In addition, recommendations corresponding to stocks which have a relatively large number of outstanding recommendations are also more affected by sentiment, which may indicate that the effect of sentiment and herding are related.

However, like Baker and Wurgler (2006), we also find that the intensity of the effect of several firm characteristics (e.g. size, age, etc.) depends on the prevailing sentiment, where in several cases (particularly in the case of financial distress) the effect actually "flips" signs, conditional upon the prevailing sentiment. This phenomenon and in particular the "sign-flip" indicates that although the sentiment effect is very strong and highly significant, sentiment, in general, is quite a complicated phenomenon which is not always fully understood. Nevertheless, the striking result of this study is that although we deal with a different dependent variable and cover a different period than those in Baker and Wurgler (2006), the sentiment effect in both studies is very similar, including the peculiar sign-flip phenomenon. These similarities may indicate not only that sentiment affects analysts and less sophisticated investors in a similar way, but also that the effect of sentiment on analysts' recommendations, at least partially, drives the effect in stock prices. This is because investors' decisions are not only affected by the prevailing sentiment, but

also by analysts' recommendations, which are already under the influence of the prevailing sentiment.

The remainder of the paper is organized as follows: Section 2 presents the data and methodology used to create the orthogonal variables employed in this study. Section 3 presents the empirical results of the time-series analysis, which employs aggregate market data. Section 4 presents the empirical results of the cross-section analysis, which makes use of data taken from individual firms. Section 5 concludes.

2. Data and methodology

We use I/B/E/S Summary Statistics (Consensus Recommendations) files as the data source for sell-side analysts' recommendations. The data includes 989,309 records over the period of November 1993 – March 2010. Note that the data also include recommendations of firms which no longer exist; thereby avoiding any survival bias. The I/B/E/S database assigns each recommendation a rating number, according to the analyst recommendation; the ratings are as follows: 1 = strong buy, 2 = buy, 3 = hold, 4 = underperform, 5 = sell. Like many other studies on this topic, we reverse the rating ordering. To avoid confusion, we do not change the ratings, but rather add a minus sign to the rating numbers, so that the largest number (minus 1) indicates a positive recommendation (strong buy) and the smallest number (minus 5) indicates a negative recommendation (sell).

Note that each broker determines how his internal recommendation rating system is mapped into the I/B/E/S five-point scale, where this mapping must allow for negative to negative ratings, positive to positive ratings and neutral to neutral ratings. These mapping methods are not uniform across the brokers and, more importantly, may vary over time. Considering the whole period as a one-time period may bias the results as, according to Kadan, Madureira, Wang, and Zach (2009), new regulations have affected recommendation practices during this period. They show

that since the National Association of Securities Dealers (NASD) Rule 2711 and the New York Stock Exchange (NYSE) modification to Rule 472 regulations have been in place many brokers have moved from a five-point scale to a three-point scale (buy, hold and sell). Fortunately, the I/B/E/S also provides information regarding the percentages of buy and sell recommendations out of all recommendations, where these variables are substantially less sensitive to the various mapping methods. This is because buy and sell recommendations remain buy and sell recommendations under the three-point scale system and the I/B/E/S five-point scale system. For example, mapping a buy recommendation into either 1 or 2 affects the mean of all outstanding recommendations of that particular stock, but does not affect the average percentages of buy and sell recommendations. Therefore, in this study we mainly use the ratio between these two variables (buy and sell) as the main recommendation variable, as is further explained below.

Every month, for each stock with at least one outstanding recommendation the I/B/E/S reports a summary record that includes several variables, from which we use the mean recommendation (and the median recommendation in the robustness checks), the standard deviation of all outstanding recommendations and the percentage of buy recommendations (ratings 1 and 2), and sell recommendations (ratings 4 and 5).

We conduct a time-series analysis which employs aggregate market data as well as a cross-section analysis which employs data taken from individual firms. In the time-series analysis, we aggregate the market recommendation variables on a monthly basis. Thus, each month we calculate the arithmetical average of all mean recommendations (corresponding to all stocks that have outstanding recommendations during that month), denoted as MEANREC. Similarly, each month we calculate the arithmetical average of all median recommendations, denoted as MEDREC, the arithmetical average of all standard deviations of recommendations,

denoted as STDREC, the arithmetical average of all percentages of buy, and the average of all percentages of sell recommendations. Finally, we calculate the ratio of the average percentage of buy recommendations divided by the average percentage of sell recommendations, denoted as BUYSELL.

We also conduct a cross-section analysis. In the cross-section analysis, we use the individual firm's recommendation variables without first aggregating them. This panel-data analysis enables us to study the relations between the sentiment effect on analysts' recommendations and the various characteristics of the firm, e.g., age, size, etc.[4]

The employed market sentiment in this study is the well-known Baker and Wurgler's (2006) sentiment index. This index is based on a weighted average of six variables, which are commonly considered in the literature as proxies for investor sentiment. These variables are trading volume, as measured by NYSE turnover; the dividend premium; the closed-end fund discount; the number of and first-day returns on IPOs; and the equity share in new issues. The index itself is provided by Baker and Wurgler in Jeffrey Wurgler's homepage.[5]

As Baker and Wurgler note, some of the variables that incorporate the sentiment index contain idiosyncratic components unrelated to sentiment, and which are also affected by economic fundamentals. Therefore, in constructing their sentiment index, they employ the variables orthogonal to macroeconomic variables, i.e. net of the macroeconomic variables' effects; hence, their orthogonal index is as close as possible to a pure sentiment index. As analysts' recommendations are certainly affected by economic fundamentals, we also establish recommendation

[4]Working with individual records, the percentage of sell recommendations may be zero. Therefore, in this case we technically add one to both the denominator and the numerator of the BUYSELL ratio and define it as the percentage of buy recommendation plus one divided by the percentage of sell recommendation plus one.

[5]See http://pages.stern.nyu.edu/~jwurgler/. Note that we do not use their paper's original index but rather their updated index, which also covers the years 2006 – 2007. For further reading on this index, see Baker and Wurgler (2006).

variables which are orthogonal to macroeconomic variables, i.e. net of possible economic variables' effects. Following Baker and Wurgler (2006, 2007), to control for market fundamentals, as a first step we regress the recommendation variables, defined above, on the same macroeconomic variables employed by Baker and Wurgler. These variables are: real growth in industrial production (Federal Reserve Statistical Release G.17); real growth in consumer durables, nondurables and services (all from BEA National Income Accounts); employment (BLS, All Employees); and a dummy variable for NBER recessions. The residuals from these regressions are then used as the recommendation *orthogonal variables,* which are orthogonal to macroeconomic variables. These orthogonal variables are denoted as $MEANREC^{\perp}$, $STDREC^{\perp}$, and $BUYSELL^{\perp}$, where the superscript $\perp$ stands for being orthogonal to macroeconomic variables.[6]

Having a relatively long time period has the advantage of covering sub-periods, some of which are characterized by positive sentiment and others that are characterized by negative sentiment. However, covering this relatively long time period, one must relate to one major issue: during the studied period, some new important regulations were imposed on analysts. These new regulations have probably induced some systematic changes in recommendation practices. In October 2000, the Securities and Exchange Commission (SEC) enacted the Regulation Fair Disclosure (FD), which prohibits firms from selectively disclosing management information to analysts. The empirical evidence shows that this regulation has affected market practice; yet, with mixed empirical evidence regarding the possible effects (see, Agrawal, Chadha, and Chen, 2006; Bailey, Li, Mao, and Zhong, 2003;

[6]One may consider other possible economic variables. However, as these selected variables are very likely to represent the state of the economy and, as these variables are employed by Baker and Wurgler, for the sake of consistency we employ the same set of economic variables. Nevertheless, in the cross-section analysis in Section 4, we also account for the contemporaneous stock market performance as another indicator of economic fundamentals. In addition, we also control for the recommendations' year to account for particularly good and bad years, in terms of average recommendations.

and Herrmann, Hope, and Thomas, 2008). In May 2002, the SEC approved the NASD Rule 2711 (Research Analysts and Research Reports) and the NYSE modification to Rule 472 (Communications with the Public) (hereafter referred to as regulations NASD 2711 and NYSE 472). The rules' effective implementation date was no later than September 9, 2002. Finally, in December 2002, the SEC announced the Global Research Analyst Settlement, which settled allegations that analysts from leading firms provided misleading information to investors.

There is some evidence that these regulations have affected analysts' recommendations. In a comprehensive study on the effect of these regulations on various variables, Kadan, Madureira, Wang, and Zach (2009) show that that since the regulations have been in place, optimistic recommendations have become less frequent and more informative, whereas neutral and pessimistic recommendations have become more frequent and less informative. Barber, Lehavy, McNichols, and Trueman (2006) find a decrease in the overall percentage of buy recommendations between January 2000 and June 2003, particularly among sanctioned investment banks. To control for the possible effects of these regulations on our findings, we employ two methods. First, we control for the regulations' effects by adding dummy variables for the periods when the regulations were in place. Second, taking a sharper approach, we conduct an analysis for the two sub-periods: before the regulations were imposed and since then.

In the empirical analysis reported below, we first briefly describe the raw recommendation variables and then focus on the orthogonal variables, which are the relevant variables for the sentiment effect analysis. We then present a cross-section analysis to explore the types of firm characteristics that affect the association between analysts' recommendations and sentiment.

3. The aggregate effect of sentiment on analysts' recommendations

In this section, we empirically explore the aggregate sentiment effect on analysts' recommendations.

3.1. Analysts' recommendations: A preliminary analysis

Figure 1 presents the aggregate non-orthogonal recommendation variables: MEANREC, MEDREC, STDREC and BUYSELL.

<< Insert Figure 1 >>

As can be seen from Figure 1a, MEANREC and MEDREC (i.e. the mean and the median recommendation variables) are almost identical. Indeed, as the regression analyses corresponding to MEANREC and MEDREC yield almost identical results, for brevity's sake, in this study we report only the results corresponding to MEANREC.

MEANREC and BUYSELL are also very similar (see Figure 1a), with a correlation coefficient corresponding to these two variables of 0.9, which is highly significant with a *t*-value of 29.07 (see Table 1).

<< Insert Table 1 >>

This high correlation coefficient corresponding to these two variables is expected. However, there is a fundamental difference between these two variables: While MEANREC is based on all recommendations, BUYSELL is based on explicit buy and sell recommendations only, and it is not affected by "hold" recommendations. Moreover, as previously explained, BUYSELL is substantially less sensitive to individual brokers' mapping methods from their internal rating systems into the I/B/E/S five-point scale and to the changes in these mapping methods, which took place when the regulations' reform occurred in 2002. Therefore, in the analysis below, we provide some analyses corresponding to the two variables, MEANREC and BUYSELL, and then focus mainly on the BUYSELL.

As a preliminary indication of the association between analysts' recommendation and market sentiment, note that the correlation coefficients corresponding to MEANREC and BUYSELL with Baker and Wurgler's sentiment index (not orthogonal) are 0.69 and 0.81, respectively. However, the most interesting result in Figure 1b is that STDREC looks like a mirror projection of MEANREC (and BUYSELL) around the horizontal axis. Correspondingly, the correlation coefficients corresponding to STDREC with MEANREC and BUYSELL are -0.87 and -0.93, with *t*-values of -24.67 and -34.42, respectively. This surprising result suggests that the dispersion across recommendations on the same stock increases, on average, in periods which are characterized by relatively unfavorable recommendations and decreases, on average, in periods which are characterized by relatively favorable recommendations.

By definition, MEANREC, BUYSELL and STDREC variables are directly related to the state of the economy. In particular, we expect that, on average, favorable economic conditions lead to relatively favorable recommendations, while unfavorable economic conditions lead to relatively unfavorable recommendations. Moreover, the sentiment index (not orthogonal) may also be affected by economic conditions. Thus, any correlation corresponding to the recommendation variables, as well as any correlation corresponding to recommendation variables with the sentiment index may be spurious, due to a possible simultaneous effect of economic fundamentals on all these variables. Therefore, in an attempt to eliminate the effect of economic fundamentals, we first derive the orthogonal version of these variables; hence obtaining the variables after accounting for the effect of several major economic variables. As we heavily rely on Baker and Wurgler's sentiment index (denoted as BWSI), for consistency's sake, in deriving the orthogonal variables we follow their methodology and employ the same macroeconomic variables mentioned in the previous section.

Figure 2 juxtaposes the orthogonal variables, $MEANREC^{\perp}$ and $BUYSELL^{\perp}$, with Baker and Wurgler's orthogonal sentiment index, $BWSI^{\perp}$.

<< Insert Figure 2 >>

Notably, both $MEANREC^{\perp}$ and $BUYSELL^{\perp}$ share many similarities with $BWSI^{\perp}$. These variables tend to increase from 1996 up to 2002, when a drastic drop is recorded in 2002. Similarly, these variables reveal a trough in 2003 and tend to increase thereafter. The $BWSI^{\perp}$, for which we have data up to 2007, reveals a similar pattern providing a first indication that after accounting for the economic variables analysts' recommendations are still affected by sentiment. Indeed, the correlation coefficients corresponding to $MEANREC^{\perp}$ and $BUYSELL^{\perp}$ with $BWSI^{\perp}$, reported in Panel 2 in Table 2, are 0.47 and 0.63, with *t*-values of 6.85 and 10.43, respectively.

<< Insert Table 2 >>

As expected, the correlation coefficients corresponding to the recommendation orthogonal variables with the sentiment index are smaller than with the raw (non-orthogonal) recommendation variables (compare Tables 1 and 2). Thus, the economic variables account for a substantial portion of the correlation between recommendations and the sentiment index, reported in Table 1. As by definition sentiment effect should be net of the effect of economic variables on analysts' recommendations, in the remainder of this study we employ the orthogonal variables. However, to shed some light on the relative impact of economic variables and sentiment on recommendations, in Appendix A we also report the basic regression with *raw* variables.

Finally, the last panel in Table 2 reports the serial correlations of the three orthogonal recommendation variables. As can be seen, the variables are significantly serially correlated up to 5-7 lags. We use this information in employing the Newey-West (1987) standard errors throughout the regression analysis to account for serial correlation.

Figure 3 presents a scatter diagram of $\text{MEANREC}^{\perp}$ and $\text{BUYSELL}^{\perp}$ as a function of $\text{BWSI}^{\perp}$. Each point in the figure is the value of $\text{MEANREC}^{\perp}$ (Figure 3a) or $\text{BUYSELL}^{\perp}$ (Figure 3b) in a certain month, as a function of $\text{BWSI}^{\perp}$ in the same month.

<< Insert Figure 3 >>

As can be seen from the figures, both recommendation variables tend to increase when sentiment increases, and to decrease when sentiment decreases. This is particularly apparent as regards $\text{BUYSELL}^{\perp}$ in Figure 3b.

Having shown these preliminary results corresponding to $\text{MEANREC}^{\perp}$, $\text{BUYSELL}^{\perp}$ and the sentiment index, we next quantify the association between sentiment and analysts' recommendations by employing a regression analysis.

3.2. Regression analysis of analysts' recommendations and sentiment: Time-series analysis

As mentioned above, in the rest of the paper we employ the relevant *orthogonal* variables. Table 3 reports the results of the following regression:

$$\text{REC}_t^{\perp} = \gamma_0 + \gamma_1 \text{BWSI}_t^{\perp} + \gamma_2 \text{REC}_{t-1}^{\perp} + \varepsilon_t, \qquad (1)$$

where $\text{REC}_t^{\perp}$ and $\text{REC}_{t-1}^{\perp}$ are either $\text{MEANREC}_t^{\perp}$ or $\text{BUYSELL}_t^{\perp}$ (orthogonal) in month t and in the previous month, respectively; and $\text{BWSI}_t^{\perp}$ is Baker and Wurgler's sentiment index (orthogonal) in month t.

<< Insert Table 3 >>

The last panel in Table 2, as well as the Durbin-Watson statistics in Table 3, reveal that the recommendation variables are serially correlated. To deal with any serial correlation problems, as well as possible heteroskedasticity, in all regressions we report the *t*-values corresponding to Newey and West's (1987) standard errors. We report the Newey-West *t*-values with 7 lags, which conform to the maximum

lagged serial correlation variable, which is statistically significant among $MEANREC^{\perp}$ and $BUYSELL^{\perp}$ (see the last panel in Table 2). In unreported tests, we confirm that the results are very similar with a larger number of lags. Furthermore, in all the regressions in this section, we include the one-month lagged dependent variable, REC_{t-1}, which is found to be highly significant as an explanatory variable.[7] Nevertheless, as many tests also reveal some serial correlation with the lagged variable, we report the Newey-West *t*-values, without explicitly restating this each time we refer to the *t*-values.[8]

Panel 1 in Table 3 corresponds to $MEANREC^{\perp}$, while Panel 2 corresponds to $BUYSELL^{\perp}$ as the dependent variables. As can be seen in Test 1, the coefficient corresponding to $BWSI_t^{\perp}$ is positive and significant with a (Newey-West) *t*-value of 2.43. Test 2 also includes the lagged $MEANREC^{\perp}$ ($MEANREC_{t-1}^{\perp}$) as an explanatory variable, which is highly significant.[9] The coefficient corresponding to $BWSI_t^{\perp}$ in this case is positive and insignificant, with a *t*-value of 1.72.

The results corresponding to $BUYSELL^{\perp}$ in Panel 2 are substantially more significant. In both tests in Panel 2 the coefficients corresponding to $BWSI_t^{\perp}$ are positive and highly significant with *t*-values of 4.97 and 3.48, respectively. Moreover, the R square in both tests is 0.39 and 0.74, suggesting that sentiment is an important factor in determining $BUYSELL^{\perp}$.

To sum up, the results in Table 3 reveal that $BUYSELL^{\perp}$ is highly correlated with sentiment. This correlation, which is robust as regards serial correlation, is probably not due to economic conditions, as it exists after accounting for several

[7]Adding variables which are further lagged into the past (e.g. two months' lag, etc.), the coefficients corresponding to these variables are generally insignificant and do not change the main results. Therefore, for brevity's sake, we report the regression with a one-month lag variable only.

[8]As expected, in all the regressions the OLS *t*-values are much larger than the Newey-West *t*-values, revealing double-digit absolute values in the cross-section analysis.

[9]With the lag-dependent variable as an explanatory variable, the Durbin-Watson statistic is biased towards underestimating serial correlation. Therefore, in this case Durbin (1970) suggests the h statistic, which is an unbiased normally distributed statistic for a large sample.

major macroeconomic variables. MEANREC$^{\perp}$, on the other hand, reveals less significant results. As BUYSELL$^{\perp}$ is less sensitive to the individual brokers' mapping methods and to changes over time in these methods, in the remainder of this study we focus on this variable.

We next turn to explore the effect of the various regulations on BUYSELL$^{\perp}$ and to test whether the changes in regulations account for the correlation between BUYSELL$^{\perp}$ and sentiment.

3.3. Sensitivity analysis: Controlling for Regulation FD, NASD 2711 and NYSE 472 with alternate time-periods

The 2000 – 2002 period corresponded with major regulation reforms, which probably altered analysts' recommendation practices. The purpose of the following analysis is to refine the previous regressions by considering all of these regulations. Thus, in the following regressions we disentangle the sentiment effect from the regulations' effects. As the exact date when the various regulations began affecting analysts' practices is not completely clear, we conduct a sensitivity analysis by considering various critical dates in determining the relevant regulation periods.

In Table 4, we first report the relations between recommendations and sentiment, by including dummy variables for different periods, which conform to the various regulations and their time span. Utilizing a more precise method, in Table 5 we conduct two separate analyses for the two sub-periods: the pre-regulation period, and the post-regulation period. Although using the second method decreases the number of observations corresponding to each regression, this method is more precise than the dummy variable method.

Table 4 reports the results of the following regression:

$$\mathrm{BUYSELL}_t^{\perp} = \gamma_0 + \gamma_1 \mathrm{BWSI}_t^{\perp} + \gamma_2 \mathrm{BUYSELL}_{t-1}^{\perp} + \gamma_3 \mathrm{REGD}_t + \gamma_4 \mathrm{REGFD}_t + \varepsilon_t, \quad (2)$$

where $BUYSELL_t^{\perp}$ and $BUYSELL_{t-1}^{\perp}$ are the BUYSELL variables in month t and the previous month, respectively; $BWSI_t^{\perp}$ is Baker and Wurgler's sentiment index in month t; $REGD_t$ is a dummy variable for the NASD 2711 and NYSE 472 period; and $REGFD_t$ is a dummy variable for the Regulation FD period corresponding to October 2000 – December 2007.

<< Insert Table 4 >>

While many brokers formally adopted the NASD 2711 and NYSE 472 regulations in September 2002, other brokers probably adopted them earlier. Furthermore, it is plausible to assume that the implementation of these regulations by at least some brokers was a gradual process, which probably continued during the time span from the introduction of the regulations in May 2002, to September 2002, which was the last month to adopt them. To account for this possible time span, we run Regression (2) with four alternate definitions of REGD: Test 1 from December 2002 (the month when the Global Research Analyst Settlement was announced), Tests 2 from September 2002 (the last month for adopting the regulations), Test 3 from July 2002 (which conforms to the time when Barber, Lehavy, McNichols, and Trueman, 2006, observed the beginning of a unique trend in the percentage of buy, hold and sell recommendations and when, according to Kadan, Madureira, Wang, and Zach, 2009, changes in the regulatory environment began), and finally Test 4 from May 2002 (when the NASD 2711 and NYSE 472 regulations were approved by the SEC). In all tests, the coefficient corresponding to $BWSI^{\perp}$ is positive and highly significant, with Newey-West t-values ranging from 3.09 to 3.14, depending on the employed regulation period.

Tests 5 and 6 include the Regulation FD dummy variable, REGFD. Test 5 includes this dummy variable only, and Test 6 also includes REGD. The results in these tests are very similar to those in the previous tests. In both tests the coefficient

corresponding to $BWSI_t^{\perp}$ is positive and highly significant. The coefficients corresponding to the regulations, REGD and REGFD, are negative—except for the period of December 2002 – December 2007 in Test 1—but insignificant. Thus, although regulations may affect the mean recommendation, we do not find a significant effect of the regulations on $BUYSELL^{\perp}$.

To further refine the analysis, we next divide the data into two periods: the pre-regulation period and the post-regulation period where, in this case, we focus on the more important NASD 2711 and NYSE 472 regulations. To account for the time span during which the regulations were implemented, there are two definitions for the pre-regulation period: November 1993 – April 2002, which conforms to the SEC approval of the regulations, and November 1993 – August 2002, which conforms to the last month of implementing the regulations—September 2002. The post-regulation period is September 2002 – December 2007 (as other alternate periods yield very similar results, for brevity's sake, we do not report them).

Table 5 reports the results of Regression (1), where the data corresponds to the various sub-periods.

<< Insert Table 5 >>

The first two tests in Table 5 correspond to the two alternate definitions of the pre-regulation sub-period, while the last test corresponds to the post-regulation sub-period. Similar to the results corresponding to the whole period (see the last test in Table 3), in all of the tests, the coefficient corresponding to $BUYSELL^{\perp}$ is positive and significant. Obviously, the *t*-values in this case are smaller, relative to those in the whole-period case, due to the reduced number of observations. However, the existence of a significant correlation between $BUYSELL^{\perp}$ and sentiment also during the sub-periods provides compelling evidence that this correlation is not due to the new regulations and the implied changes in recommendation practices.

In sum, we find a significant sentiment effect on recommendations, which is most profound with the $\text{BUYSELL}^{\perp}$ variable; this significant result is robust as regards the regulation reforms and the implied changes in analysts' recommendation practices.

3.4. Causality tests: Regression analysis with changes in variables

Does sentiment affect analysts' recommendation or do recommendations affect the variables which compose the sentiment index? In an attempt to identify an indication for causality, in this section we test whether sentiment affects analysts' recommendations with a time lag. The most straightforward way to test for a possible lag effect is to run a regression similar to Regression (1) with negative and positive lagged sentiment index variables. However, because the autocorrelation corresponding to $\text{BWSI}_t^{\perp}$ and its lagged variables is very high (for example, the correlation coefficient corresponding to $\text{BWSI}_t^{\perp}$ with $\text{BWSI}_{t-1}^{\perp}$ is 0.95), multicollinearity affects the significance of the results. To deal with this problem, we employ the changes in variables, rather than the variables themselves. This procedure eliminates the problem of multicollinearity and also provides an additional robustness test for the results obtained thus far.

Table 6 reports the results of the following regression:

$$\Delta\text{BUYSELL}_t^{\perp} = \gamma_0 + \sum_{i=-2}^{2} \gamma_{1i} \Delta\text{BWSI}_{t+i}^{\perp} + \varepsilon_t , \tag{3}$$

where $\Delta\text{BUYSELL}_t^{\perp} \equiv \text{BUYSELL}_t^{\perp} - \text{BUYSELL}_{t-1}^{\perp}$ is the change in BUYSELL in month t; $\Delta\text{BWSI}_{t+i}^{\perp} \equiv \text{BWSI}_{t+i}^{\perp} - \text{BWSI}_{t+i-1}^{\perp}$ is the change in Baker and Wurgler's sentiment index; and to test the possible effect of lagged variables, we select the following values: $i = -2,-1,0,+1$ and +2.

<< Insert Table 6 >>

Test 1 in Table 6 includes $\Delta BWSI_t^{\perp}$ as the only explanatory variable. As can be seen, the coefficient corresponding to $\Delta BWSI^{\perp}$ is positive and significant with a *t*-value of 3.25.[10] Thus, the correlation corresponding to analysts' recommendations with sentiment is not only significant as regards the variables themselves, but also as regards the changes in these variables.

Test 2 also includes the one- and two-month positive and negative lagged variables. Notably, only the coefficient corresponding to $BWSI^{\perp}$ is significant with a *t*-value of 3.32. The other lagged variables are insignificant. The above findings suggest that at the monthly resolution employed in this study both BUYSELL and sentiment fluctuate in the same month. Therefore, with monthly data we cannot identify an indication for causality. It is plausible that analysts' recommendations are affected by sentiment which, in turn, affects asset prices with some delay. However, to reach ultimate conclusions and in order to analyze causality a better resolution of the data is called for, e.g. weekly or daily data. Unfortunately, such short horizon data on the investment sentiment index is unavailable. However, consistent with other studies cited in the Introduction, which find that analysts are also affected by non-economic factors, it is reasonable to assume that analysts are affected by sentiment rather than the other way around.

3.5. Dispersion of analysts' recommendations and sentiment

Does the degree of homogeneity of analysts' recommendations vary across time? Is the degree of homogeneity related to market sentiment? If the answer to these questions is positive, it implies that the standard deviation across analysts' recommendations varies with sentiment. We briefly report below that the standard

[10]Note that including the lag-dependent variable as an additional explanatory variable in Regression (3) does not eliminate serial correlation and the coefficient corresponding to this variable is insignificant.

deviation is indeed significantly related to sentiment, which opens up a host of new research issues. For example, does the reduction in the standard deviation during periods when sentiment is relatively high indicate that we observe more herding among analysts when sentiment is high? As sentiment is not an economic factor, does the disagreement about the idiosyncratic risk imply that when the sentiment is low more trade in the stock takes place? As this point is not the main issue of this paper, we report below the basic facts regarding sentiment and standard deviation, and leave the exploration of the meaning of these results to future research.

Table 7 reports the result of the following regression with various combinations of explanatory variables:

$$\text{STDREC}_t^{\perp} = \gamma_0 + \gamma_1 \text{BWSI}_t^{\perp} + \gamma_2 \text{STDREC}_{t-1}^{\perp} + \gamma_3 \text{REGD}_t + \varepsilon_t \ , \qquad (4)$$

where $\text{STDREC}_t^{\perp}$ and $\text{STDREC}_{t-1}^{\perp}$ are the standard deviation of recommendations (orthogonal) in month *t* and the previous month, respectively; $\text{BWSI}_t^{\perp}$ is Baker and Wurgler's sentiment index in month *t*; and REGD_t is a dummy variable for NASD 2711 and NYSE 472 regulations corresponding to the period of September 2002 – December 2007.

<< Insert Table 7 >>

Test 1 in Table 7 includes the sentiment index, $\text{BWSI}^{\perp}$, as the only explanatory variable. Test 2 also includes the lagged dependent variable, $\text{STDREC}_{t-1}^{\perp}$, and Test 3 also includes the regulations dummy variable, REGD. In all three tests reported in Table 7 the coefficient corresponding to $\text{BWSI}^{\perp}$ is negative and significant, with *t*-values of -3.81, -3.37, and -2.44, respectively. Thus, when sentiment is high, analysts' recommendations tend to be more homogenous. Namely, not only the mean recommendation (and BUYSELL ratio), but also the standard deviation of recommendations is correlated with sentiment.

4. Firm characteristics: Cross-section analysis of analysts' recommendations and sentiment

Baker and Wurgler (2006) advocate and empirically document that the prices of stocks which are more difficult to arbitrage are more likely to be affected by investor sentiment. While there are several reasons why some stocks are relatively more difficult to arbitrage than others, the main reason for this phenomenon—which is also relevant to the case of analysts' recommendations—corresponds to valuation difficulties which vary across firms. Namely, when the objective valuation models are less reliable, subjective judgment, which may be affected by sentiment, plays an important role in the stock evaluation process.

The main hypothesis tested in this section—hereafter referred to as the "Evaluation Difficulties Hypothesis" or EDH—is that stocks which are relatively more difficult to evaluate are not only more difficult to arbitrage, as was profoundly analyzed by Baker and Wurgler (2006),[11] but their recommendations are probably more exposed to the influence of sentiment. Thus, according to the EDH, we expect that the effect of sentiment on analysts' recommendations will be more profound in stocks of small, young, volatile, unprofitable, dividends non-payer, growing, and financially distressed firms. As pessimism or optimism (the sign of the sentiment) may affect the magnitude and the sign of the sentiment effect, in the cross-section regressions we also test whether or not the sentiment effects vary conditionally, in accordance with the sign of the sentiment.

We stress at the outset that, although the hypothesis tested in this section is similar and based on the one tested by Baker and Wurgler, there is a distinct difference between the two studies: inspired by their research, we analyze the

[11] As Baker and Wurgler note, a stock which is more difficult to evaluate is not only more difficult to arbitrage, but may also be more exposed to sentiment-based speculative demands. However, as this study deals with analysts' recommendations and focuses on stocks which are more difficult to evaluate, we are not required to deal with this distinction.

sentiment effect on analysts' recommendations, whereas they analyze the sentiment effect on stock prices. These, however, are not two independent issues, as analysts' recommendations probably have some influence on investors' decisions. Therefore, the effect of sentiment on analysts' recommendations found in this study may, at least partially, derive the effect in stock prices. Of course, we do not rule out the very likely possibility that investors are also directly affected by sentiment.

4.1. Cross-section analysis methodology

In the following analysis, we employ a panel data and run the following regression:

$$\begin{aligned}\text{BUYSELL}_{it}^{\perp} = \gamma_0 + \big[1 + \delta_1 \text{ME}_{it\text{-1y}} + \delta_2 \text{LARGECAP}_{it\text{-1y}} + \delta_3 \text{SMALLCAP}_{it\text{-1y}} + \\ \delta_4 \text{MICCAP}_{it\text{-1y}} + \delta_5 \text{AGE}_{it} + \delta_6 \text{STD}_{it\text{-1y}} + \delta_7 (\text{E}_{it-1y}/\text{ME}_{it-1y}) + \delta_8 (\text{D}_{it-1y}/\text{ME}_{it-1y}) + \\ \delta_9 (\text{BE}_{it-1y}/\text{ME}_{it-1y}) + \delta_{10} (\text{HGROWTH}_{it-1y}) + \delta_{11} (\text{FDISTRESS}_{it-1y}) + \\ \delta_{12} \text{NUMREC}_{it} + \delta_{13} \text{RET}_t \big] \times \gamma_1 \text{BWSI}_t^{\perp} + \gamma_2 \text{ME}_{it\text{-1y}} + \gamma_3 \text{AGE}_{it} + \gamma_4 \text{STD}_{it\text{-1y}} + \\ \gamma_5 (\text{E}_{it-1y}/\text{ME}_{it-1y}) + \gamma_6 (\text{D}_{it-1y}/\text{ME}_{it-1y}) + \gamma_7 (\text{BE}_{it-1y}/\text{ME}_{it-1y}) + \gamma_8 \text{NUMREC}_{it} + \\ \gamma_9 \text{RET}_t + \sum_{j=1}^{14} \gamma_{j+9} \text{YEAR}_{jt} + \varepsilon_{it},\end{aligned} \tag{5}$$

where $\text{BUYSELL}_{it}^{\perp}$ is the firm's BUYSELL variable (orthogonal) in month t; $\text{ME}_{it\text{-1y}}$ is the previous calendar year's natural logarithm of market equity, measured as price times shares outstanding (where in all variables the subscript $_{1y}$ stands for the previous calendar year and the data is taken from either the merged Center of Research in Security Prices CRSP-Compustat database or the I/B/E/S database); $\text{LARGECAP}_{it\text{-1y}}$, $\text{SMALLCAP}_{it\text{-1y}}$ and $\text{MICCAP}_{it\text{-1y}}$ are dummy variables for large, small and micro size firms (where the mid-size firm variable is omitted to avoid multicollinearity); AGE_{it} is the natural logarithm of the number of years since the stock's Initial Public Offering (IPO), with a maximum value of 30 years; $\text{STD}_{it\text{-1y}}$ is the stock's monthly standard deviation over the previous calendar year, as long as

there were at least eight monthly returns with which to estimate it; E_{it-1y}/BE_{it-1y} is the previous calendar year's earnings-to-book-equity ratio if earnings were positive and zero otherwise; D_{it-1y}/BE_{it-1y} is the previous calendar year's dividends-to-book-equity ratio; BE_{it-1y}/ME_{it-1y} is the previous calendar year's book-to-market ratio, where $HGROWTH_{it-1y}$ is a dummy variable for extremely low book-to-market values (growth firms) and $FDISTRESS_{it-1y}$ is a dummy variable for extremely high book-to-market values (financially distressed firms);[12] $NUMREC_{it}$ is the natural logarithm of the stock's number of outstanding recommendations in month t; RET_t is the return on the NYSE Composite Index in month t; $BWSI_t^{\perp}$ is Baker and Wurgler's sentiment index (orthogonal) in month t; and $YEAR_{jt}, j = 1...14$ are the recommendation year's dummy variables from 1993 to 2006, where 2007 is omitted to avoid multicollinearity.

According to the EDH, small firms are expected to be more affected by sentiment than large firms because they are more difficult to evaluate. However, the size variable (ME) is well-known to capture multiple effects like the Fama and French (1992) risk factor, the January effect, etc. (see for example Keim, 1983; Blume and Stambaugh, 1983. Although the January effect has been weakened in more recent years, according to Schwert, 2003, it has not completely disappeared). As a result, the EDH may be insufficient to explain the size effect, as it only considers one aspect of size: its effect on difficulties in evaluation of the firm in all states of nature. Therefore, to refine the analysis, in addition to the ME variable, we also add dummy variables for firms whose size is different from the Midcap category. These dummy variables are intended to capture specific differences, if they exist, between

[12]We follow Baker and Wurgler (2006) and employ similar variables: Earnings (E) is income before extraordinary items (Item 18) plus income statement deferred taxes (Item 50) minus preferred dividends (Item 19); book equity (BE) is shareholders' equity (Item 60) plus balance sheet deferred taxes (Item 35). Dividends (D) is dividends per share at the ex date (Item 26) times Compustat's shares outstanding (Item 25).

the firms belonging to the common size categories. Thus, we add a dummy variable for large firms, whose market capitalization is over 10 billion US dollars, denoted by LARGECAP, a dummy variable for small firms, whose market capitalization is below two billion US dollars, but above 300 million US dollars, denoted by SMALLCAP, and a dummy variable for micro-firms whose market capitalization is below 300 million US dollars, denoted by MIDCAP.

Our hypothesis also posits that high-growth firms and distressed firms are more difficult to evaluate; hence, analysts' recommendations corresponding to these firms are more affected by sentiment relative to other firms. We use the book-to-market variable to identify high-growth and financially distressed firms; extremely high book-to-market values are likely to indicate distress, while extremely low values are likely to indicate high-growth opportunities. Therefore, we add dummy variables for the lowest 2.5% observations, which are presumably composed of mainly high-growth firms and denoted by HGROWTH, and the highest 2.5% observations, presumably composed mainly of firms which are financially distressed and denoted by FDISTRESS.

We use the number of outstanding recommendations (NUMREC) as an indicator of herding exposure. Obviously, there is no herding in the case of only one outstanding recommendation. Furthermore, it is most likely that herding prevails when there are many outstanding recommendations for a stock. In this case, the hypothesis is that herding, if it exists, further increases the effect of sentiment on recommendations, because analysts who herd do not base their recommendations on fundamental objective valuation models, and therefore are more exposed to non-economic factors.

Finally, we also include the recommendation contemporaneous market return, RET. The inclusion of this variable has two purposes: First, although the employed variables in this regression are orthogonal to major macroeconomic variables it is

always possible that we do not capture all relevant economic variables. Including this variable—which is of course a major economic indicator—is another way we use to control for economic fundamentals. Second, as we shall see below, the results generally indicate that the sentiment effect is more profound when sentiment is negative than when it is positive. Thus, including this variable multiplied by $BWSI^{\perp}$ enables us to test whether the effect of sentiment depends upon stock market performance.

In the cross-section analysis, we are interested in the effect of the various variables on the association between $BWSI^{\perp}$ and $BUYSELL^{\perp}$, rather than their impact on $BUYSELL^{\perp}$ in the absence of sentiment. Therefore, we are mainly interested in the coefficients of the firm's characteristics variables, which are multiplied by the sentiment variable, $BWSI^{\perp}$, where $BWSI^{\perp}$ may be negative or positive (see Eq. 5). However, we also include these firm's specific variables on a standalone basis, as well as the dummy variables for the recommendations year (YEAR), to control for the effects of these firm's characteristics on $BUYSELL^{\perp}$ and to control for any particular year effect on $BUYSELL^{\perp}$. Like with the market return variable (RET), the year dummy variables also serves as yet another way to control for economic fundamentals, as these variables control for relatively good and bad years in terms of average recommendations.

Opening the brackets in Eq. (5), the equation can be rewritten in the following, more transparent, manner, [13]

[13]For more information on this technique, see, e.g., Kennedy (2008, p. 98).

$$
\begin{aligned}
&\mathrm{BUYSELL}_{it}^{\perp} = \gamma_0 + \gamma_1 \mathrm{BWSI}_t^{\perp} + \delta_1^* \mathrm{BWSI}_t^{\perp}(\mathrm{ME}_{it\text{-}1\mathrm{y}}) + \delta_2^* \mathrm{BWSI}_t^{\perp}(\mathrm{LARGECAP}_{it\text{-}1\mathrm{y}}) + \\
&\delta_3^* \mathrm{BWSI}_t^{\perp}(\mathrm{SMALLCAP}_{it\text{-}1\mathrm{y}}) + \delta_4^* \mathrm{BWSI}_t^{\perp}(\mathrm{MICCAP}_{it\text{-}1\mathrm{y}}) + \delta_5^* \mathrm{BWSI}_t^{\perp}(\mathrm{AGE}_{it}) + \\
&\delta_6^* \mathrm{BWSI}_t^{\perp}(\mathrm{STD}_{it\text{-}1\mathrm{y}}) + \delta_7^* \mathrm{BWSI}_t^{\perp}(\mathrm{E}_{it-1y}/\mathrm{ME}_{it-1y}) + \delta_8^* \mathrm{BWSI}_t^{\perp}(\mathrm{D}_{it-1y}/\mathrm{ME}_{it-1y}) + \\
&+ \delta_9^* \mathrm{BWSI}_t^{\perp}(\mathrm{BE}_{it-1y}/\mathrm{ME}_{it-1y}) + \delta_{10}^* \mathrm{BWSI}_t^{\perp}(\mathrm{HGROWTH}_{it-1y}) + \\
&\delta_{11}^* \mathrm{BWSI}_t^{\perp}(\mathrm{FDISTRESS}_{it-1y}) + \delta_{12}^* \mathrm{BWSI}_t^{\perp}(\mathrm{NUMREC}_{it}) + \delta_{13}^* \mathrm{BWSI}_t^{\perp}(\mathrm{RET}_t) + \\
&\gamma_2 \mathrm{ME}_{it\text{-}1\mathrm{y}} + \gamma_3 \mathrm{AGE}_{it} + \gamma_4 \mathrm{STD}_{it\text{-}1\mathrm{y}} + \gamma_5(\mathrm{E}_{it-1y}/\mathrm{ME}_{it-1y}) + \gamma_6(\mathrm{D}_{it-1y}/\mathrm{ME}_{it-1y}) + \\
&\gamma_7(\mathrm{BE}_{it-1y}/\mathrm{ME}_{it-1y}) + \gamma_8 \mathrm{NUMREC}_{it} + \gamma_9 \mathrm{RET}_t + \sum_{j=1}^{14} \gamma_{j+9} \mathrm{YEAR}_{jt} + \varepsilon_{it},
\end{aligned}
\tag{5'}
$$

where $\delta_1^* = \delta_1\gamma_1$, $\delta_2^* = \delta_2\gamma_1$, ... $\delta_{13}^* = \delta_{13}\gamma_1$. Indeed, we run the regression according to the formulation given in Eq. (5').

Baker and Wurgler find that some regression coefficients "flip" signs, as one shifts from a positive to negative sentiment period; as a result, some of these variables do not have unconditional predictive power. To test whether a flip in sign in δ_i^* occurs (i.e. if the sentiment effect is different under the two sentiment regimes), and to account for a possible difference in the intensity of the effect condition on the sign of sentiment, we conduct the main analysis, conditional upon the sign of the sentiment. Finally, to achieve a comprehensive understanding of the sentiment effect and the firm's characteristics, we also report the results of the unconditional regression, which corresponds to the weighted average of the effects under the two sentiment regimes. However, as some of the conditional regression coefficients flip their sign, depending on the prevailing sentiment, one should bear in mind that the unconditional results are not invariant to the period under consideration. A period characterized by a relatively large number of months with positive sentiment will probably reveal different unconditional results than those corresponding to a period with a relatively large number of months with negative sentiment.

To handle possible heteroskedasticity and autocorrelation, we report the Newey-West *t*-values with 7 lags. Any observation with missing data is omitted. Overall, we analyze 459,730 observations out of about 800,000 observations

available for the period of 1993 – 2007, a period for which the sentiment index is available (recall that the overall 989,309 observations, which are used to calculate the orthogonal variables, are for the whole period of 1993 – 2010, but the sentiment index is not available after 2007; hence, we have a smaller number of observations). The omitted observations include firms that did not survive their first year, firms which were not traded for at least eight months during the relevant calendar year, foreign firms' ADRs that do not appear in the CRSP database, etc.

As the current analysis is based on distinct observations, rather than on the observations' means, to reduce the possible influence of outliers and data errors in the main tests we also run the regression after omitting the lowest 0.01% and the highest 0.01% observations corresponding to each variable.[14] Because in many cases the omissions overlap across the variables, overall 181 observations are omitted. As we find that the results with and without the outliers, as well as without 0.1% highest and lowest observations (about 1,800 observations are omitted), are very similar, we only report the first case.

4.2. Cross-section regression results

Table 8 reports the results of Regression (5'). Tests 1–2 include only the observations wherein sentiment ($BWSI^{\perp}$) was positive, Tests 3–4 include only the observations wherein sentiment was negative, and Tests 5–6 include all observations, i.e. unconditional as regards sentiment.[15]

<< Insert Table 8 >>

The main results of Table 8 are as follows:

[14]This does not include the AGE well-defined variable. Note that three variables: micro-size firms, high growth firms and financially distressed firms' variables are all intended to explore firms with extreme parameters. Therefore, it is important that we do not omit too many observations.

[15]In the robustness tests, we also define high and low sentiment as being above and below the median value, rather than zero. However, as the results are very similar in both cases, for brevity's sake we do not report these tests in this paper.

1. Most of the results, albeit not all of them, conform to the EDH, asserting that sentiment mainly affects the recommendations of stocks which are more difficult to evaluate.

2. For most of the variables, the sign and the significance of the effect of sentiment on $BUYSELL_{ti}^{\perp}$ depends on the sign of the sentiment.

3. The sentiment effect studied in this paper is a complicated phenomenon, sometimes lacking a clear economic or psychological interpretation. While for most variables we have a clear logical explanation, a few results still remain a puzzle. Yet, one thing is certain; the conditional sentiment effects are very strong, highly significant, and robust.

4. As expected, most of the firm's characteristics are significant on a standalone basis (see Panel B in Table 8), implying that these variables are indeed associated with stocks' valuation, and correspondingly with average recommendations. In addition, most of the year variables are significant, implying that these variables indeed capture particular years' effects, which are probably related to economic conditions during these years.

With these general results in mind, let us elaborate on the regression results.

As a preliminary analysis, Tests 1, 3 and 5 repeat Regression (1), where $BWSI_{t}^{\perp}$ is the only explanatory variable; in all tests the association between sentiment and analysts' recommendations is positive and highly significant (*t*-values of 4.97, 11.58 and 13.45, respectively). Thus, consistent with the time-series analysis results, when sentiment is positive it increases $BUYSELL^{\perp}$, as both sentiment and the $BWSI^{\perp}$ coefficient are positive. When sentiment is negative, it decreases $BUYSELL^{\perp}$, as sentiment is negative and the $BWSI^{\perp}$ coefficient is positive. Moreover, the $BWSI^{\perp}$ coefficient in Test 3 (0.0965), which corresponds to negative

sentiment, is almost seven times larger than that in Test 1 (0.0140), which corresponds to positive sentiment. Thus, the effect of sentiment on analysts' recommendations is substantially more profound when sentiment is negative.

One possible explanation for this difference in the magnitude of the sentiment effect under the two sentiment regimes relies on the theory asserting that the damage induced by a loss hurts much more than the benefit from a gain (this is the well-known concept of "loss aversion", see, e.g., Kahneman and Tversky, 1979). In the case of financial analysts, where performance determines their prestige, a loss corresponds to issuing erroneous recommendations and a gain corresponds to issuing correct recommendations. Thus, when sentiment is negative, analysts—being pessimistic—are more concerned about errors than gains. As a result, they are probably more inclined to protect themselves against possible errors in recommendations by relying more on subjective (pessimistic) judgment, rather than objective valuation models.

We turn now to the results of the more relevant comprehensive regressions, given in Tests 2, 4 and 6, in which all the variables may simultaneously affect the association between sentiment and $\text{BUYSELL}^{\perp}$. According to the EDH, we expect the δ_i^* coefficients corresponding to size (ME and LARGECAP), age, earnings and dividends to be negative, regardless of the sign of the sentiment because an increase in these variables indicates that the firm is less difficult to evaluate and presumably less affected by sentiment. Let us illustrate this claim with the age variable, AGE and when the regression is conditional on the sign of sentiment.

When sentiment is positive, we expect, on average, a positive sentiment effect on the dependent variable. However, this positive effect decreases as the age of the firm increases. Indeed, a negative AGE coefficient multiplied by the positive sentiment implies that the *reduction* from this average positive sentiment is larger for

older firms; hence, the remaining positive sentiment effect of old firms is smaller. Similarly, when sentiment is negative we expect, on average, a negative sentiment effect on the dependent variable. Thus, a negative AGE coefficient multiplied by the negative sentiment variable induces a positive term. Therefore, the smaller the age of the firm, the smaller the *added* positive value to the negative average sentiment effect; and correspondingly, the larger (in absolute value) the remaining negative effect of sentiment on the dependent variable. A similar logic holds for size, earnings, and dividends variables, where an increase in these variables indicates that the firm is more easily evaluated. Note that in the unconditional regression the average sentiment for the whole studied period is positive; hence, the interpretation of positive and negative regression coefficients is the same as in the conditional analysis when corresponding to positive sentiment.

The opposite positive sign is expected for the coefficients corresponding to small-size (SMALLCAP and, in particular, MICCAP), volatility, high growth, and financial distress variables. The reason for this assertion is that an increase in these variables indicates that the firm is more difficult to evaluate (the explanation corresponding to the effect with negative and positive sentiment regimes is very similar to the one employed with the AGE variable). Finally, based on the hypothesis that herding and sentiment are associated, the δ_{12}^{*} coefficient corresponding to the number of outstanding recommendations variable is also expected to be positive, as an increase in this variable indicates that the likelihood of herding increases—a case where sentiment may play a larger role in comparison to the situation where herding does not exist. In Table 8, we add a column with + and – to indicate what is the expected sign of the regression coefficient according to the EDH. This will facilitate the comparison between the expected and observed results.

While the results which are consistent with the EDH speak for themselves, as regards the few results which contradict the EDH, we suggest some explanations, but admit that some puzzles remain and more research and explanations on this matter will probably be suggested in the future. Note, however, that rich patterns in the sentiment effects, including a flip-in-sign phenomenon, is not unique to this study: Baker and Wurgler (2006), who explain stock prices rather than analysts' recommendations, also find that several variables flip signs depending on sentiment. They also provide several explanations for these phenomena which, for brevity's sake, we do not repeat here.

The coefficient corresponding to ME is positive and significant when sentiment is negative (a *t*-value of 4.64, see Panel A in Table 8). Thus, when sentiment is negative the size effect is in contradiction with the EDH, as the regression results reveal that large firms are generally more affected by sentiment than small firms. However, as previously mentioned, the size variable is well-known to capture multiple effects and the EDH probably oversimplifies the effect of size on the dependent variable. Therefore, to test for specific effects while controlling for the general size effect, we also add the dummy variables for the common firm-size categories. Indeed, the specific size effects are consistent with the EDH. When sentiment is positive the coefficients corresponding to both SMALLCAP and MICCAP are positive and significant (*t*-values of 3.83 and 3.44, respectively), and the coefficient corresponding to LARGECAP is insignificant. Thus, when sentiment is positive small and very small firms, which are presumably more difficult to evaluate, are more affected by sentiment than mid-range and large firms (recall that in this case ME is insignificant). When sentiment is negative, the coefficient corresponding to LARGECAP is negative and highly significant (a *t*-value of -7.47), which is also consistent with the EDH, and the coefficients corresponding to SMALLCAP and MICCAP are insignificant, suggesting that beside the general size

affect in ME, large firms, which are presumably less difficult to evaluate, are less affected by sentiment than other firms.

The coefficient corresponding to AGE is insignificant when sentiment is positive and negative, and highly significant when sentiment is negative (a *t*-values of -7.79). As explained above, the interpretation of the negative coefficient when sentiment is negative is straightforward and consistent with the EDH. Moreover, the result, revealing that age affects the sentiment effect only when sentiment is negative, is consistent with our general claim that the effect of sentiment is more profound when sentiment is negative.

The coefficient corresponding to STD is positive and highly significant only when sentiment is negative (a *t*-value of 6.01). Thus, when sentiment is negative the larger the stock volatility, the larger the effect of sentiment on $\text{BUYSELL}^{\perp}$. This result conforms to the EDH, as the larger the volatility, presumably the more difficult it is to evaluate the firm. Similar to AGE, obtaining a significant effect only when sentiment is negative is consistent with the claim that the effect of sentiment is more profound when sentiment is negative. Indeed, the STD coefficient is insignificant in the unconditional regression in Test 6.

We turn now to the profitability variables. The coefficient corresponding to earnings (E/ME) is negative and, like the previous two variables, it is significant only when sentiment is negative (a *t*-value of -2.99). Thus, consistent with the EDH when sentiment is negative, profitable firms—which are presumably less difficult to evaluate—are less affected by sentiment. In contrast, the coefficient corresponding to dividends (D/ME) is positive, but barely significant, when sentiment is negative (a *t*-values of 2.35). This positive coefficient when sentiment is negative is a puzzle, as it is in contradiction with the EDH, implying that firms that pay dividends, which are presumably less difficult to evaluate, are more affected by sentiment. However, in the

unconditional regression in Test 6 the coefficient is negative, which is consistent with the EDH (a t-value of -2.53).

Let us now consider the book-to-market variables (BE/ME, HGROWTH and FDISTRESS). As Baker and Wurgler note, the book-to-market ratio captures several effects which are difficult to disentangle. Thus, although when sentiment is positive the coefficient corresponding to BE/ME is positive and significant (a t-values of 3.00), it is difficult to interpret this result. Therefore, we also add the two dummy variables for extreme book-to-market values to capture any effect corresponding to high growth firms as well as financially distressed firms.

Consistent with the EDH, the coefficient corresponding to high growth firms (HGROWTH) is positive and highly significant when sentiment is positive (a t-values of 6.39). Thus, when sentiment is positive, firms which face high growth opportunities are more affected by sentiment than other firms. The same result is observed with the unconditional regression (a t-values of 5.20), whereas this coefficient is insignificant when sentiment is negative. A possible explanation for this asymmetry under the two sentiment regimes may be that while positive sentiment allegedly induces more possible opportunities for high-growth firms in comparison to other firms—thus making them even more difficult to evaluate—negative sentiment induces the same negative effect on all firms, regardless of their growth opportunities; hence, no particular sentiment effect is observed. It is interesting to note that Baker and Wurgler also observe a unique investors' demand for high-growth firms when sentiment is high (a positive sentiment in our case), which disappears when sentiment is low.

The coefficient corresponding to financial distress (FDISTRESS) significantly flips sign, conditional upon sentiment; it is negative when sentiment is positive and positive when sentiment is negative, where in both cases it is highly significant (t-values of -6.39 and 4.83, respectively). Thus, when sentiment is

positive financially distressed firms are less affected by sentiment than other firms; and the opposite holds true when sentiment is negative. In addition, this coefficient is negative and significant in the unconditional regression (t-values of -4.34). The positive coefficient when sentiment is negative is consistent with the EDH, as it implies that distressed firms, which are presumably more difficult to evaluate, are also more affected by negative sentiment. The negative coefficient corresponding to positive sentiment contradicts the EDH. However, like with the size variable, the EDH probably oversimplifies the effect of financial distress on the analyst's work by only considering evaluation difficulties. If, for example, optimistic analysts view financially distressed firms as being less competent than other firms as regards exploiting the allegedly positive conditions induced by the positive sentiment, due to a lack of capital and managerial incentives, then indeed these firms' recommendations will be less affected by positive sentiment. This explanation is supported by the result showing that when sentiment is negative these firms are more affected by negative sentiment. Being already under distress, pessimistic analysts are probably even more concerned about the survival of these firms. It is worth mentioning that Baker and Wurgler also find that distressed firms are more affected by sentiment when sentiment is low, and less affected by sentiment when sentiment is high. Thus, the two studies reveal similar patterns.

Finally, it is interesting to note that the effects of high-growth and financially distressed firms are more profound than the general book-to-market effect. In particular, the significance level of the coefficients corresponding to HGROWTH and FDISTRESS are substantially larger than the ones corresponding to the book-to-market variable (BE/ME).

The coefficient corresponding to NUMREC is positive and significant when sentiment is positive (a t-value of 3.59). Thus, when sentiment is positive firms whose stock has a relatively large number of outstanding recommendations is more

affected by sentiment than firms with only a few outstanding recommendations. This result may indicate that the effects of sentiment and herding are related. As herding is less likely in stocks with only one or a few outstanding recommendations, it is possible that, when sentiment is positive, analysts who herd, rather than base their recommendations on fundamental models follow other optimistic analysts who overestimate stock valuations, thereby further increasing the effect of sentiment. This result conforms to the results of Welch (2000), who finds that herding is more profound when the market is bullish, which is usually also associated with positive sentiment.

As expected, most of the coefficients corresponding to the firm's characteristic control variables (γ_3 to γ_7) are significant (see Table 8 Panel B). Thus, these variables, which are related to firm performance, are, as expected, associated with $BUYSELL^{\perp}$.

Finally, most of the years' variables are significant, implying that these variables indeed capture particular years' effects, which are probably related to the economic conditions existing during these years.

6. Concluding Remarks

Nowadays, it is well documented that investors do not always make rational investment decisions, and that the stock market is not perfectly efficient, at least in the short run. Ample experimental and economic evidence reveal that sentiment affects asset prices. Recognizing the important role that non-economic factors play in the capital market, Baker and Wurgler (2006) have developed a sentiment index, which measures the sentiment level for each month. In contrast to classical theory, they show that sentiment significantly affects assets prices, in some cases in a very complicated manner.

The common belief is that the less sophisticated investors, also called Noise Traders, are the ones who are mainly affected by sentiment; hence, they are responsible for the effect in asset prices. In this study, we find that sophisticated investors—the financial analysts—are not immune to the effect of sentiment. Thus, the professional analysts, who presumably employ scientific valuation models, also change their recommendations depending on the prevailing sentiment. As analysts' recommendations are affected by sentiment, it is possible that this phenomenon accounts, at least partially, for the observed phenomenon in asset prices.

A time-series analysis of analysts' recommendations reveals that when investor sentiment is positive, analysts issue more optimistic recommendations, while the opposite takes place when sentiment is negative. This sentiment effect is highly significant and robust as regards the effects of macroeconomic variables, serial correlation and, in particular, the various regulations (the NASD Rule 2711, the modification to NYSE Rule 472 and Regulation FD) which were imposed about a decade ago and have presumably affected analysts' practices. Moreover, when sentiment is positive, financial analysts also tend to issue recommendations that are more homogeneous, and the opposite holds true when sentiment is negative. This result may imply that the sign of sentiment and herding among analysts are two related variables.

In the cross-section analysis, we study the interrelations between firm characteristics and the sentiment effect. For most variables, the results are highly significant. According to Baker and Wurgler's (2006) theory, sentiment has a greater influence on the prices of stocks that are more difficult to evaluate. Our results generally conform to this theory. The cross-section analysis of analysts' recommendations generally reveals that recommendations corresponding to stocks of small, young, volatile, unprofitable, dividend non-payers, growing, and financially distressed firms are more affected by sentiment. Recommendations corresponding to

stocks with a large number of recommendations are also more affected by sentiment, which may indicate that when herding takes place sentiment plays a more crucial role in the forming of recommendations.

Finally, an analysis conditional upon the sign of the sentiment reveals a dramatic asymmetry in the sentiment effect, where the effect of sentiment on analysts is generally more profound when sentiment is negative and, in particular, also when the stock market is bearish. Although most of the results conform to the evaluation difficulties hypothesis, some of the results remain a puzzle. Thus, sentiment remains a complicated phenomenon, sometimes lacking a clear economic or psychological interpretation. Yet, the highly significant results show that financial analysts, like other less sophisticated investors, are affected by emotions, mood and sentiment. Of course, we do not rule out that financial analysts are immune to sentiment and change their recommendations because they know that the less sophisticated investors are affected by sentiment, which in turn, affects prices. However, this explanation is very unlikely given the evidence in other studies showing that analysts are also affected by non-economic variables.

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Figure 1a

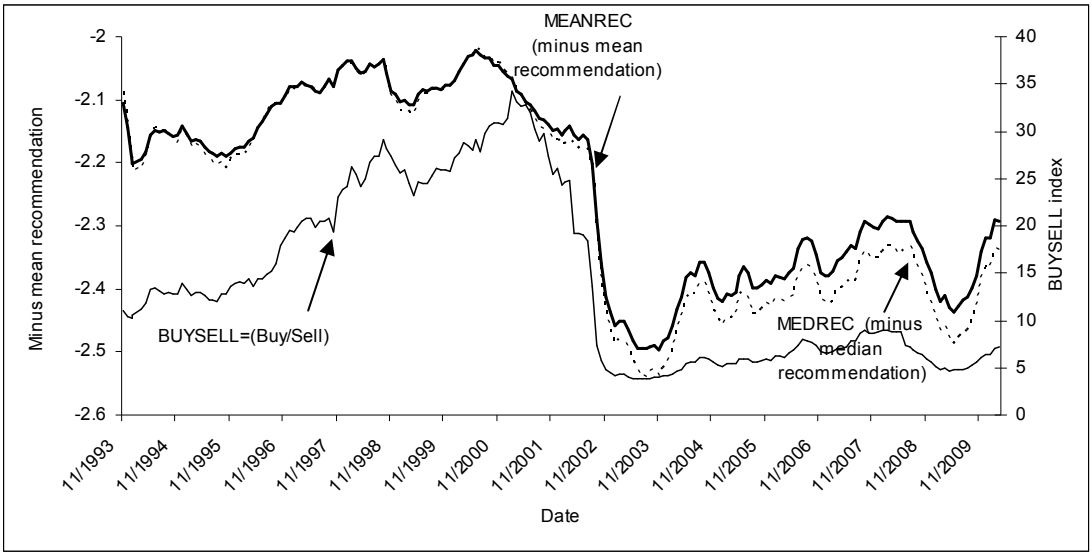

Figure 1b

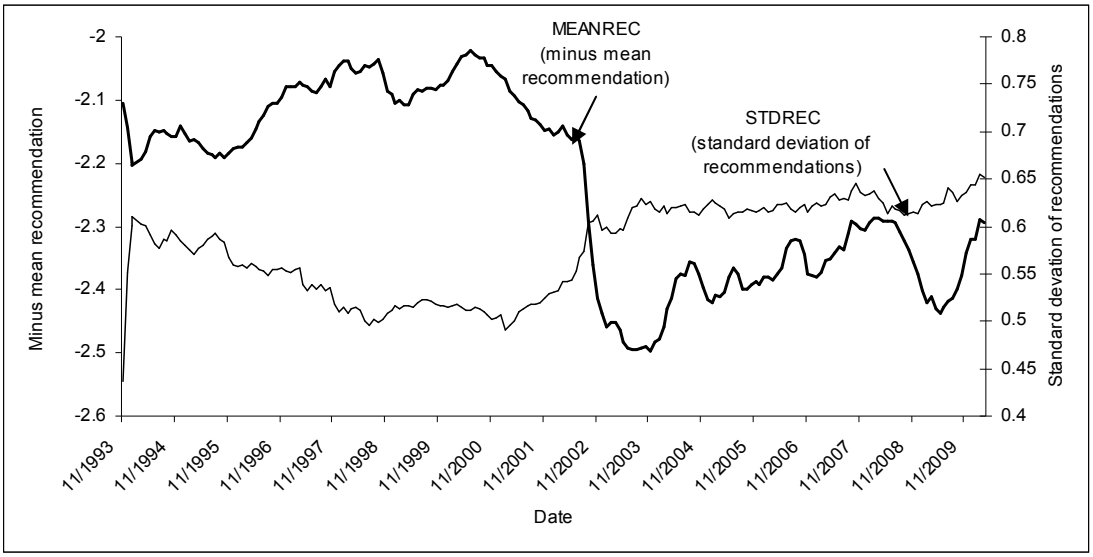

Figure 1. MEANREC, MEDREC, STDREC, and BUYSELL variables

Figure 1a presents the monthly average recommendation (MEANREC), the monthly median recommendation (MEDREC), and the monthly average percentage of buy recommendations divided by the average percentage of sell recommendations (BUYSELL). Figure 1b presents the monthly average recommendation (MEANREC) and the monthly average standard deviation of recommendations (STDREC). Recommendation data covers the period of September 1993 – March 2010 with 989,309 recommendations. As the I/B/E/S database ratings are on a scale from 1 to 5, where 1 is strong buy (i.e. positive recommendation) and 5 is sell (i.e. negative recommendation), for presentation purposes we always use the mean recommendation with a negative sign in front of it.

Figure 2a

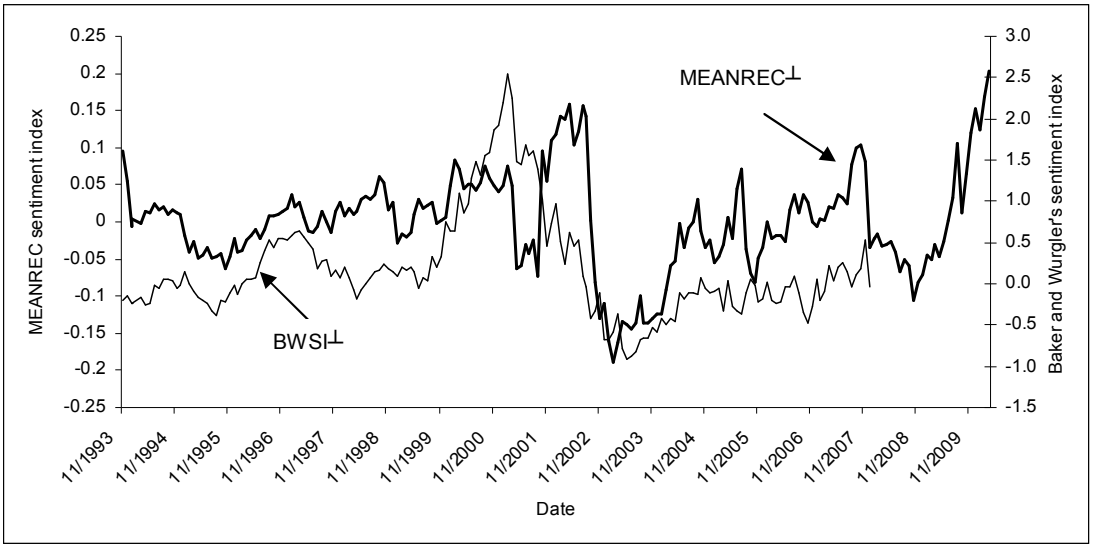

Figure 2b

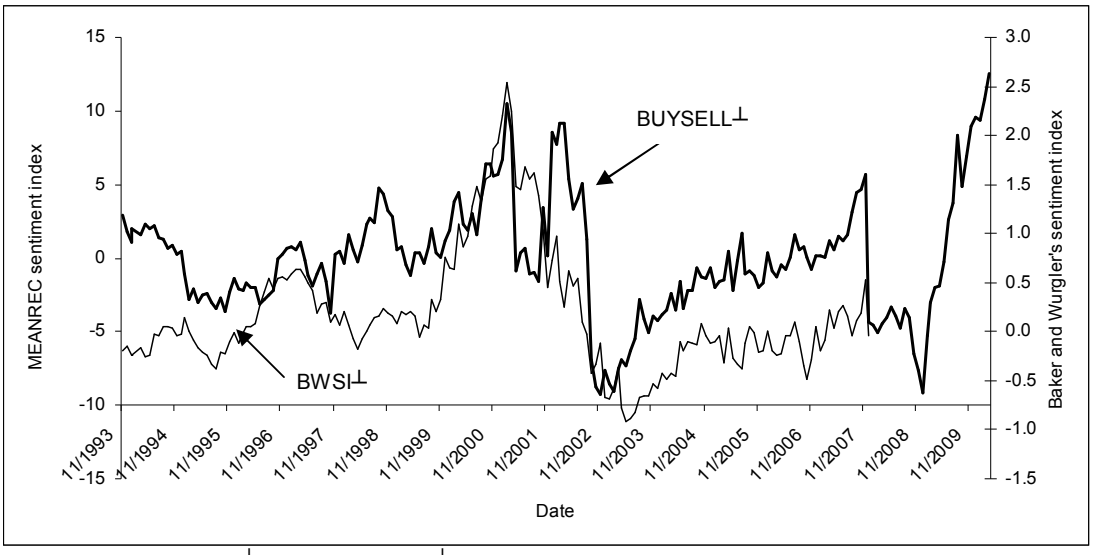

Figure 2. MEANREC$^{\perp}$ and BUYSELL$^{\perp}$ indices vs. Baker and Wurgler's sentiment index
The Figures compare the monthly average recommendation (MEANREC$^{\perp}$) and the monthly average buy to sell ratio (BUYSELL$^{\perp}$) indices with Baker and Wurgler's sentiment index (BWSI$^{\perp}$). All three indices are orthogonal to macroeconomic variables. Recommendation data covers the period of September 1993 – March 2010, with 989,309 recommendations, while Baker and Wurgler's sentiment index covers the period from November 1993 to December 2007.

Figure 3a

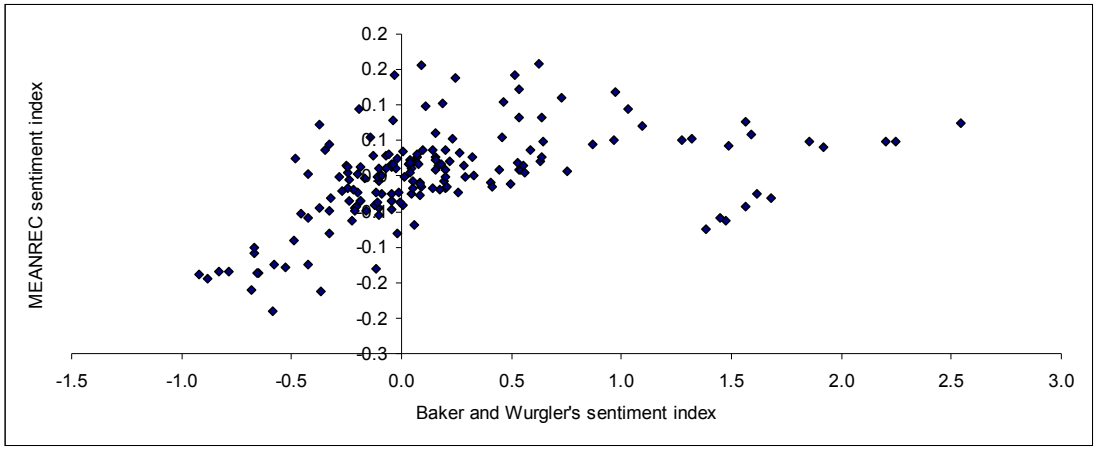

Figure 3b

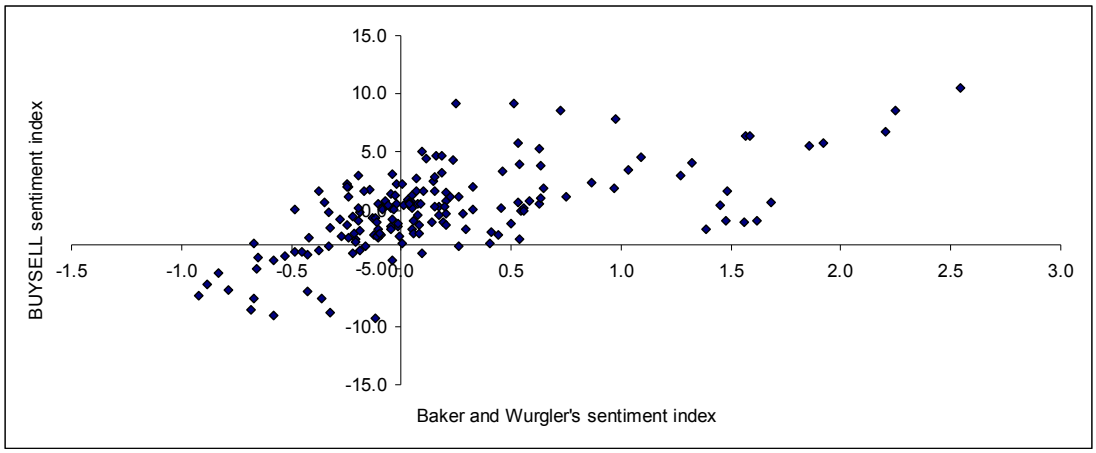

Figure 3. MEANREC$^{\perp}$ and BUYSELL$^{\perp}$ indices as a function of Baker and Wurgler's sentiment index

The Figures depict the monthly average recommendation (MEANREC$^{\perp}$) and the monthly average buy to sell ratio (BUYSELL$^{\perp}$) indices, as a function of the contemporaneous Baker and Wurgler's sentiment index (BWSI$^{\perp}$). All three indices are orthogonal to macroeconomic variables. Recommendation data covers the period from November 1993 to December 2007.

Table 1: Descriptive statistics of raw recommendation variables

The table reports some statistics of the recommendation raw variables. The upper panel reports the basic statistics, while the lower panel reports the correlation coefficients across the variables. Recommendation data covers the period of November 1993 – March 2010 with 989,309 recommendations and Baker and Wurgler's sentiment index covers the period of November 1993 – December 2007. MEANREC is the monthly average recommendation (with a minus sign in front), BUYSELL is the monthly average percentage of buy recommendations divided by the average percentage of sell recommendations, STDREC is the monthly average standard deviation of recommendations, and BWSI is Baker's and Wurgler's sentiment index. One and two asterisks indicate a two-tail test significance level of 5% and 1%, respectively.

		MEANREC	BUYSELL	STDREC	BWSI
Average		-2.23	14.27	0.58	0.28
Standard deviation		0.15	9.15	0.05	0.60
Skewness		-0.19	0.57	-0.38	1.23
Maximum		-2.02	34.21	0.65	2.24
Minimum		-2.50	3.80	0.44	-0.79
Correlation Coefficients					
BUYSELL		0.90			
	t-value	(29.07**)			
STDEV		-0.87	-0.93		
	t-value	(-24.67**)	(-34.42**)		
BWSI		0.69	0.81	-0.66	
	t-value	(12.38**)	(17.66**)	(-11.54**)	

Table 2: Descriptive statistics of recommendation indices orthogonal to macroeconomic variables

The table reports the statistics of the recommendation indices employed in this study. The upper panel reports the basic statistics, Panels 2–5 report the cross correlation across the variables for various periods, while the lower panel reports the autocorrelation across the variables. Recommendation data covers the period of November 1993 – March 2010 with 989,309 recommendations and Baker and Wurgler's sentiment index covers the period of November 1993 – December 2007. MEANREC is the monthly average recommendation, BUYSELL is the monthly average buy to sell ratio, STDREC is the monthly average standard deviation of recommendations, and BWSI is Baker's and Wurgler's sentiment index. The superscript $^{\perp}$ stands for the residuals from the regression of these variables on macroeconomic variables. One and two asterisks indicate a two-tail test significance level of 5% and 1%, respectively.

		MEANREC$^{\perp}$	BUYSELL$^{\perp}$	STDREC$^{\perp}$	BWSI$^{\perp}$
1. Descriptive statistics					
Average		0.00	0.00	0.00	0.18[1]
Standard deviation		0.07	4.02	0.02	0.62
Skewness		0.06	0.40	-2.75	1.41
Maximum		0.20	12.51	0.04	2.54
Minimum		-0.19	-9.27	-0.16	-0.92
2. Correlation Coefficients: 11/1993 - 12/2007 (whole period)					
BUYSELL$^{\perp}$		0.88			
	t-value	(25.51**)			
STDREC$^{\perp}$		-0.62	-0.64		
	t-value	(-11.11**)	(-11.55**)		
BWSI$^{\perp}$		0.47	0.63	-0.37	
	t-value	(6.85**)	(10.43**)	(-5.11**)	
3. Correlation Coefficients: 11/1993 - 9/2000 (pre all regulations)					
BUYSELL$^{\perp}$		0.86			
	t-value	(15.38**)			
STDREC$^{\perp}$		-0.61	-0.45		
	t-value	(-6.93**)	(-4.59**)		
BWSI$^{\perp}$		0.53	0.43	-0.15	
	t-value	(5.68**)	(4.27**)	(-1.34)	
4. Correlation Coefficients: 11/1993 - 8/2002 (pre NASD 2711 regulation)					
BUYSELL$^{\perp}$		0.80			
	t-value	(13.74**)			
STDREC$^{\perp}$		-0.63	-0.59		
	t-value	(-8.16**)	(-7.42**)		
BWSI$^{\perp}$		0.22	0.51	-0.24	
	t-value	(2.31*)	(5.98**)	(-2.50*)	
5. Correlation Coefficients: 9/2000 - 12/2007 or 3/2010 (post regulations)					
BUYSELL$^{\perp}$		0.90			
	t-value	(19.02**)			
STDREC$^{\perp}$		-0.65	-0.83		
	t-value	(-8.04**)	(-14.17**)		
BWSI$^{\perp}$		0.73	0.74	-0.49	
	t-value	(8.49**)	(8.58**)	(-4.47*)	
6. Serial Correlation Coefficients					
Lag 1 (*t*-1)		0.88	0.88	0.72	
	t-value	(25.34**)	(26.36**)	(14.58**)	
Lag 2 (*t*-2)		0.76	0.78	0.49	
	t-value	(16.21**)	(17.22**)	(7.75**)	
Lag 3 (*t*-3)		0.65	0.67	0.34	
	t-value	(11.87**)	(12.65**)	(5.01**)	
Lag 4 (*t*-4)		0.54	0.56	0.25	
	t-value	(8.96**)	(9.53**)	(3.65**)	
Lag 5 (*t*-5)		0.41	0.45	0.16	
	t-value	(6.23**)	(7.07**)	(2.26*)	
Lag 6 (*t*-6)		0.29	0.33	0.10	
	t-value	(4.17**)	(4.88**)	(1.43)	
Lag 7 (*t*-7)		0.19	0.22	0.10	
	t-value	(2.74**)	(3.16**)	(1.33)	
Lag 8 (*t*-8)		0.08	0.10	0.08	
	t-value	(1.19)	(1.37)	(1.10)	

[1]Note that the average BWSI$^{\perp}$ is not zero, as was originally calculated by Baker and Wurgler for the period of July 1965 – December 2007. In contrast, we use it only from November 1993.

Table 3: Recommendation indices orthogonal to macroeconomic variables and sentiment

The table reports the results of the following regression:

$$\mathrm{REC}_t^{\perp} = \gamma_0 + \gamma_1 \mathrm{BWSI}_t^{\perp} + \gamma_2 \mathrm{REC}_{t-1}^{\perp} + \varepsilon_t,$$

where $\mathrm{REC}_t^{\perp}$ and $\mathrm{REC}_{t-1}^{\perp}$ are either MEANREC or BUYSELL recommendation indices (orthogonal to macroeconomic variables) in month t and the previous month, respectively; and $\mathrm{BWSI}_t^{\perp}$ is Baker and Wurgler's sentiment index (orthogonal to macroeconomic variables) in month t. The data covers the period of November 1993 – December 2007. The first line of each test reports the regression coefficients, while the next lines report the corresponding t-values (in brackets) for OLS, and Newey-West standard errors with 7 lags, respectively. One and two asterisks indicate a two-tail test significance level of 5% and 1%, respectively. SC stands for rejecting the null hypothesis asserting no serial correlation.

$$1.\ \mathrm{MEANREC}_t^{\perp} = \gamma_0 + \gamma_1 \mathrm{BWSI}_t^{\perp} + \gamma_2 \mathrm{MEANREC}_{t-1}^{\perp} + \varepsilon_t$$

	γ_0	$\mathrm{BWSI}_t^{\perp}$	$\mathrm{MEANREC}_{t-1}^{\perp}$	Durbin-Watson[1]	R^2/F
1.	-0.0096	0.0480		0.32 (SC)	0.22
	(-0.94)	(2.43*)			
				Durbin h-test	
2.	-0.0021	0.0100	0.8211	1.91 (SC)	0.76
	(-0.77)	(1.72)	(20.41**)		

$$2.\ \mathrm{BUYSELL}_t^{\perp} = \gamma_0 + \gamma_1 \mathrm{BWSI}_t^{\perp} + \gamma_2 \mathrm{BUYSELL}_{t-1}^{\perp} + \varepsilon_t$$

	γ_0	$\mathrm{BWSI}_t^{\perp}$	$\mathrm{BUYSELL}_{t-1}^{\perp}$	Durbin-Watson[1]	R^2/F
3.	-0.6567	3.5509		0.41 (SC)	0.39
	(-1.40)	(4.97**)			
				Durbin h-test	
4.	-0.2066	1.0181	0.7432	2.25 (SC)	0.74
	(-1.24)	(3.48**)	(14.04**)		

[1]The critical values for the Durbin-Watson statistic to reject the null hypothesis asserting no serial correlation at a 5% significance level are d_L=1.74 and d_H=1.76. The critical values for the Durbin h statistic to reject the null hypothesis are h=-1.65 and h=1.65.

Table 4: Controlling for NASD Rule 2711, NYSE modification to Rule 472 and Regulation FD alternate periods

The table reports the results of the following regression for the whole period of November 1993 - December 2007:

$$\text{BUYSELL}_t^{\perp} = \gamma_0 + \gamma_1 \text{BWSI}_t^{\perp} + \gamma_2 \text{BUYSELL}_{t-1}^{\perp} + \gamma_3 \text{REGD}_t + \gamma_4 \text{REGFD}_t + \varepsilon_t,$$

where $\text{BUYSELL}_t^{\perp}$ and $\text{BUYSELL}_{t-1}^{\perp}$ are BUYSELL index (orthogonal) in month *t* and the previous month, respectively; $\text{BWSI}_t^{\perp}$ is Baker and Wurgler's sentiment index (orthogonal) in month *t*; REGD_t is a dummy variable for NASD Rule 2711 and NYSE modification to Rule 472; and REGFD_t is a dummy variable for the Regulation FD period from October 2000 to December 2007. The REGD_t alternate periods are: from May 2002 (when the NASD 2711 and NYSE 472 regulations were approved by the SEC), from September 2002 (the last month to implement the regulations), from December 2002 (the month when the Global Research Analyst Settlement was announced), and from July 2002 when Barber, Lehavy, McNichols, and Trueman (2006) observed the beginning of a unique trend in the percentage of buy, hold and sell recommendations and, according to Kadan, Madureira, Wang ,and Zach (2009), changes in the regulatory environment began. The first line of each test reports the regression coefficients, while the next lines report the corresponding *t*-values (in brackets) for OLS, and Newey-West standard errors with 7 lags, respectively. One and two asterisks indicate a two-tail test significance level of 5% and 1%, respectively. SC stands for rejecting the null hypothesis asserting no serial correlation.

	γ_0	$\text{BWSI}_t^{\perp}$	$\text{BUYSELL}_{t-1}^{\perp}$	REGD_t	REGFD_t	Durbin h-test[1]	R^2/F
				12/2002-12/2007			
1.	-0.2731	1.0696	0.7456	0.1598		2.26 (SC)	0.74
	(-1.03)	(3.11**)	(13.50**)	(0.47)			
				9/2002-12/2007			
2.	-0.0858	0.9292	0.7368	-0.2789		2.29 (SC)	0.74
	(-0.44)	(3.14**)	(14.31**)	(-0.79)			
				7/2002-12/2007			
3.	-0.0838	0.9228	0.7390	-0.2726		2.19 (SC)	0.74
	(-0.43)	(3.09**)	(14.50**)	(-0.79)			
				5/2002-12/2007			
4.	-0.0891	0.9278	0.7406	-0.2535		2.17 (SC)	0.74
	(-0.45)	(3.11**)	(14.56**)	(-0.78)			
5.	-0.0883	1.0118	0.7421		-0.2290	2.22 (SC)	0.74
	(-0.51)	(3.67**)	(14.34**)		(-0.73)		
				9/2002-12/2007			
6.	-0.0778	0.9650	0.7390	-0.1561	-0.1184	2.30 (SC)	0.74
	(-0.43)	(2.91**)	(14.52**)	(-0.17)	(-0.15)		

[1]The critical values for the Durbin h statistic to reject the null hypothesis are h=-1.65 and h=1.65.

Table 5: Recommendation indices and market sentiment – Sub-periods

The table reports the results of the following regression:

$$\text{BUYSELL}_t^{\perp} = \gamma_0 + \gamma_1 \text{BWSI}_t^{\perp} + \gamma_2 \text{BUYSELL}_{t-1}^{\perp} + \varepsilon_t ,$$

where $\text{BUYSELL}_t^{\perp}$ and $\text{BUYSELL}_{t-1}^{\perp}$ are BUYSELL index (orthogonal) in month *t* and the previous month, respectively; and $\text{BWSI}_t^{\perp}$ is Baker and Wurgler's sentiment index (orthogonal) in month *t*. The various periods are November 1993 – April 2002 (pre-approval of the NASD 2711 and NYSE 472 regulations by the SEC), November 1993 - August 2002 (pre the final date for implementing the NASD 2711 and NYSE 472 regulations), and September 2002 - December 2007 (post the final date for implementing the NASD 2711 and NYSE 472 regulations). The first line of each test reports the regression coefficients, while the next lines report the corresponding *t*-values (in brackets) for OLS, and Newey-West standard errors with 7 lags, respectively. One and two asterisks indicate a two-tail test significance level of 5% and 1%, respectively. SC stands for rejecting the null hypothesis asserting no serial correlation.

Period	γ_0	$\text{BWSI}_t^{\perp}$	$\text{BUYSELL}_{t-1}^{\perp}$	Durbin h-test[1]	R^2/F
1.	0.0031	0.6895	0.7507	0.09	0.68
11/1993-4/2002	(0.02)	(2.49*)	(11.57**)		
2.	-0.0042	0.7235	0.7416	0.19	0.68
11/1993-8/2002	(-0.02)	(2.62**)	(12.51**)		
3.	-0.0528	3.4312	0.5982	5.48 (SC)	0.72
9/2002-12/2007	(-0.22)	(2.74**)	(4.04**)		

[1]The critical values for the Durbin h statistic to reject the null hypothesis are h=-1.65 and h=1.65.

Table 6: The change in recommendation indices and tests for time shifts
The table reports the results of the following regression:

$$\Delta \text{BUYSELL}_t^{\perp} = \gamma_0 + \sum_{i=-2}^{2} \gamma_{1i} \Delta \text{BWSI}_{t+i}^{\perp} + \varepsilon_t ,$$

where $\Delta \text{BUYSELL}_t^{\perp} \equiv \text{BUYSELL}_t^{\perp} - \text{BUYSELL}_{t-1}^{\perp}$ is the change in the BUYSELL index orthogonal to macroeconomic variables in month t; and $\Delta \text{BWSI}_{t+i}^{\perp} \equiv \text{BWSI}_{t+i}^{\perp} - \text{BWSI}_{t+i-1}^{\perp}$ are the changes in Baker and Wurgler's sentiment index in months $t-2, t-1, t, t+1$ and $t+2$. The data covers the period of November 1993 – December 2007. The first line reports the regression coefficients, while the next lines report the corresponding *t*-values (in brackets) for OLS, and Newey-West standard errors with 7 lags, respectively. One and two asterisks indicate a two-tail test significance level of 5% and 1%, respectively. SC stands for rejecting the null hypothesis asserting no serial correlation.

	γ_0	$\Delta\text{BWSI}_{t-2}^{\perp}$	$\Delta\text{BWSI}_{t-1}^{\perp}$	$\Delta\text{BWSI}_{t}^{\perp}$	$\Delta\text{BWSI}_{t+1}^{\perp}$	$\Delta\text{BWSI}_{t+2}^{\perp}$	Durbin-Watson[1]	R^2/F
1.	-0.0468			3.9761			1.96 (SC)	0.16
	(-0.40)			(3.25**)				
							Durbin h-test	
2.	-0.0458	1.3901	-0.7543	4.0097	-0.1496	-0.6896	Not applicable	0.19
	(-0.37)	(1.46)	(-0.56)	(3.32**)	(-0.25)	(-1.15)		

[1]The critical values for the Durbin-Watson statistic to reject the null hypothesis asserting no serial correlation at a 5% significance level are d_L=1.74 and d_H=1.76.

Table 7: Recommendation standard deviation and sentiment

The table reports the results of the following regression:

$$\text{STDREC}_t^{\perp} = \gamma_0 + \gamma_1 \text{BWSI}_t^{\perp} + \gamma_2 \text{STDREC}_{t-1}^{\perp} + \gamma_3 \text{REGD}_t + \varepsilon_t ,$$

where $\text{STDREC}_t^{\perp}$ and $\text{STDREC}_{t-1}^{\perp}$ are the standard deviation of recommendations (orthogonal) in month t and the previous month, respectively; $\text{BWSI}_t^{\perp}$ is Baker and Wurgler's sentiment index (orthogonal) in month t; and REGD_t is a dummy variable for the NASD 2711 and NYSE 472 regulations corresponding to the period of September 2002 – December 2007. The data covers the period of November 1993 – December 2007. The first line of each test reports the regression coefficients, while the next lines report the corresponding *t*-values (in brackets) for OLS, and Newey-West standard errors with 7 lags, respectively. One and two asterisks indicate a two-tail test significance level of 5% and 1%, respectively. SC stands for rejecting the null hypothesis asserting no serial correlation.

	γ_0	$\text{BWSI}_t^{\perp}$	$\text{STDREC}_{t-1}^{\perp}$	REGD_t	Durbin-Watson[1]	R^2/F
1.	0.0023	-0.0111			0.56 (SC)	0.14
	(1.05)	(-3.81**)				
					Durbin h-test	
2.	0.0014	-0.0065	0.4605		8.88 (SC)	0.32
	(1.14)	(-3.37**)	(4.21**)			
					Durbin h-test	
3.	0.0002	-0.0055	0.4532	0.0026	9.25 (SC)	0.33
	(0.10)	(-2.44*)	(3.94**)	(0.75)		

[1]The critical values for the Durbin-Watson statistic to reject the null hypothesis asserting no serial correlation at a 5% significance level are d_L=1.74 and d_H=1.76. The critical values for the Durbin h statistic to reject the null hypothesis are h=-1.65 and h=1.65.

Table 8: Cross-section regressions

The table reports the results of the following regression:

$$\text{BUYSELL}_{it}^{\perp} = \gamma_0 + \gamma_1 \text{BWSI}_t^{\perp} + \delta_1^* \text{BWSI}_t^{\perp}(\text{ME}_{it\text{-1y}}) + \delta_2^* \text{BWSI}_t^{\perp}(\text{LARGECAP}_{it\text{-1y}}) +$$
$$\delta_3^* \text{BWSI}_t^{\perp}(\text{SMALLCAP}_{it\text{-1y}}) + \delta_4^* \text{BWSI}_t^{\perp}(\text{MICCAP}_{it\text{-1y}}) + \delta_5^* \text{BWSI}_t^{\perp}(\text{AGE}_{it}) +$$
$$\delta_6^* \text{BWSI}_t^{\perp}(\text{STD}_{it\text{-1y}}) + \delta_7^* \text{BWSI}_t^{\perp}(\text{E}_{it-1y}/\text{ME}_{it-1y}) + \delta_8^* \text{BWSI}_t^{\perp}(\text{D}_{it-1y}/\text{ME}_{it-1y}) +$$
$$+ \delta_9^* \text{BWSI}_t^{\perp}(\text{BE}_{it-1y}/\text{ME}_{it-1y}) + \delta_{10}^* \text{BWSI}_t^{\perp}(\text{HGROWTH}_{it-1y}) + \delta_{11}^* \text{BWSI}_t^{\perp}(\text{FDISTRESS}_{it-1y}) +$$
$$\delta_{12}^* \text{BWSI}_t^{\perp}(\text{NUMREC}_{it}) + \delta_{13}^* \text{BWSI}_t^{\perp}(\text{RET}_t) + \gamma_2 \text{ME}_{it\text{-1y}} + \gamma_3 \text{AGE}_{it} + \gamma_4 \text{STD}_{it\text{-1y}} +$$
$$\gamma_5(\text{E}_{it-1y}/\text{ME}_{it-1y}) + \gamma_6(\text{D}_{it-1y}/\text{ME}_{it-1y}) + \gamma_7(\text{BE}_{it-1y}/\text{ME}_{it-1y}) + \gamma_8 \text{NUMREC}_{it} +$$
$$\gamma_9 \text{RET}_t + \sum_{j=1}^{14} \gamma_{j+9} \text{YEAR}_{jt} + \varepsilon_{it},$$

where $\text{BUYSELL}_t^{\perp}$ is the BUYSELL (orthogonal) in moth *t*; $\text{ME}_{it\text{-1y}}$ is the previous calendar year's log of market equity (where $_{1y}$ stands for the previous calendar year); $\text{LARGECAP}_{it\text{-1y}}$, $\text{SMALLCAP}_{it\text{-1y}}$ and $\text{MICGECAP}_{it\text{-1y}}$ are dummy variables for large, small and micro size firms; AGE_{it} is the log of the number of years since the stock's Initial Public Offering (IPO); $\text{STD}_{it\text{-1y}}$ is the stock's monthly standard deviation over the previous calendar year; $\text{E}_{it-1y}/\text{BE}_{it-1y}$ is the previous calendar year's earnings-to-book-equity ratio, if earnings were positive and zero otherwise; $\text{D}_{it-1y}/\text{BE}_{it-1y}$ is the previous calendar year's dividends-to-book-equity ratio; $\text{BE}_{it-1y}/\text{ME}_{it-1y}$ is the previous calendar year's book-to-market ratio, where HGROWTH_{it-1y} is a dummy variable for the lowest 2.5% book-to-market observations and FDISTRESS_{it-1y} is a dummy variable for the highest 2.5% observations; NUMREC_{it} is the log of the stock's number of outstanding recommendations in month *t*; $\text{BWSI}_{ti}^{\perp}$ is Baker and Wurgler's sentiment index (orthogonal) in month *t*; RET_t is the return on the NYSE Composite Index in month *t*; and $\text{YEAR}_{jt}, j = 1...14$ are 14 dummy variables for the recommendation's year. The data covers the period of November 1993 – December 2007. Panel A reports the firm's characteristics effects coefficients and Panel B reports the control variable coefficients. The first line of each coefficient reports the coefficient value, while the second line reports the *t*-value (in brackets) for Newey-West standard errors with 7 lags. One and two asterisks indicate a two-tail test significance level of 5% and 1%, respectively.

A. Firm's characteristics variables

Firm's characteristic		Sign expected by the EDH	A. Positive Sentiment 1.	A. Positive Sentiment 2.	B. Negative 3.	B. Negative 4.	C. Unconditional 5.	C. Unconditional 6.
	γ_0		-0.0196 (-8.41**)	0.2028 (9.34**)	-0.0186 (-6.50**)	0.1246 (4.66**)	-0.0316 (-20.71**)	0.1611 (9.47**)
	γ_1		0.0140 (4.97**)	-0.1304 (-4.14**)	0.0965 (11.58**)	-0.0987 (-1.01)	0.0292 (13.45**)	-0.0763 (-2.66**)
Size effect	$\delta_1^* = \delta_1\gamma_1$ (ME)	−		0.007 (1.82)		0.0526 (4.64**)		0.0095 (2.79**)
Fixed size effects	$\delta_2^* = \delta_2\gamma_1$ (LARGECAP)	−		0.0177 (1.95)		-0.202 (-7.47**)		-0.0089 (-1.04)
	$\delta_3^* = \delta_3\gamma_1$ (SMALLCAP)	+		0.0284 (3.83**)		0.0363 (1.66)		0.0291 (4.15**)
	$\delta_4^* = \delta_4\gamma_1$ (MICCAP)	+		0.0437 (3.44**)		-0.0259 (-0.68)		0.0347 (2.88**)
Age effect	$\delta_5^* = \delta_5\gamma_1$ (AGE)	−		0.0083 (1.96)		-0.1089 (-7.79**)		-0.009 (-2.67**)
Volatility effect	$\delta_6^* = \delta_6\gamma_1$ (STD)	+		-0.0371 (-1.31)		0.7524 (6.01**)		-0.0316 (-1.42)
Profitability effects	$\delta_7^* = \delta_7\gamma_1$ (E/BE)	−		0.0026 (0.98)		-0.0994 (-2.99**)		-0.0032 (-1.43)
	$\delta_8^* = \delta_8\gamma_1$ (D/BE)	−		-0.0314 (-1.48)		0.082 (2.35*)		-0.0167 (-2.53*)
Book-to-market effect	$\delta_9^* = \delta_9\gamma_1$ (BE/ME)	+/–		0.0247 (3.00**)		0.0095 (0.28)		0.01 (1.19)
Fixed book-to-market effects	$\delta_{10}^* = \delta_{10}\gamma_1$ (HGROWTH)	+		0.0582 (6.39**)		-0.0061 (-0.11)		0.0471 (5.20**)
	$\delta_{11}^* = \delta_{11}\gamma_1$ (FDISTRESS)	+		-0.0964 (-6.39**)		0.2291 (4.83**)		-0.0677 (-4.34**)
Number of recommendation effect	$\delta_{12}^* = \delta_{12}\gamma_1$ (NUMREC)	+[1]		0.0162 (3.59**)		-0.0159 (-1.28)		0.0251 (7.29**)

[1]Predicted by the association of sentiment with the herding hypothesis.

B. Control variables

	A. Positive Sentiment		B. Negative Sentiment		C. Unconditional	
	1.	2.	3.	4.	5.	6.
$\delta_{13}^{*} = \delta_{13}\gamma_1$ (RET)		-0.0121 (-0.76)		-0.8782 (-6.49**)		0.0256 (1.76)
γ_2 (ME)		-0.0023 (-0.90)		0.0067 (2.37*)		-0.0017 (-0.95)
γ_3 (AGE)		-0.0575 (-15.41**)		-0.0602 (-12.41**)		-0.0437 (-16.19**)
γ_4 (STD)		0.1258 (3.66**)		0.4478 (9.43**)		0.1459 (6.20**)
γ_5 (E/BE)		0.0005 (1.30)		-0.0022 (-0.56)		0.0022 (2.02*)
γ_6 (D/BE)		-0.0102 (-1.20)		-0.0108 (-1.43)		-0.016 (-3.61**)
γ_7 (BE/ME)		-0.0653 (-4.61**)		-0.0283 (-1.32)		-0.0444 (-3.25**)
γ_8 (NUMREC)		-0.0102 (-2.71**)		-0.0358 (-8.17**)		-0.0221 (-9.29**)
γ_9 (RET)		0.0843 (5.50**)		-0.2699 (-6.61**)		0.0183 (1.50)
γ_{10} (1993)				-0.0266 (-2.22*)		-0.0284 (-2.54*)
γ_{11} (1994)		-0.0611 (-6.57**)		-0.0343 (-4.00**)		-0.0418 (-5.64**)
γ_{12} (1995)		-0.053 (-5.76**)		-0.0611 (-7.05**)		-0.0611 (-8.42**)
γ_{13} (1996)		-0.0731 (-9.38**)		-0.0481 (-5.12**)		-0.0693 (-9.83**)
γ_{14} (1997)		-0.063 (-8.52**)				-0.063 (-9.17**)
γ_{15} (1998)		-0.0533 (-7.02**)		-0.0448 (-5.09**)		-0.0449 (-6.60**)
γ_{16} (1999)		-0.0368 (-4.88**)		-0.0271 (-2.86**)		-0.0327 (-4.73**)
γ_{17} (2000)		0.0019 (0.22)				-0.0274 (-3.48**)
γ_{18} (2001)		0.0081 (0.83)				-0.0316 (-3.60**)
γ_{19} (2002)		0.0771 (8.58**)		-0.0517 (-4.92**)		0.0212 (2.73**)
γ_{20} (2003)				-0.0817 (-8.84**)		-0.0781 (-9.38**)
γ_{20} (2004)		-0.0369 (-3.61**)		-0.0279 (-3.31**)		-0.0291 (-3.89**)
γ_{21} (2005)		-0.0353 (-4.02**)		-0.0096 (-1.15)		-0.0171 (-2.34*)
γ_{22} (2006)		-0.0135 (-1.91)		-0.0013 (-0.18)		-0.0042 (-0.62)

Appendix A

To shed some light on the impact of the economic variables on analysts' recommendations, and in particular on the relative impact of economic variables and sentiment on recommendations, in this Appendix we report the basic regression with raw variables. Thus, we run the following regression:

$$\mathrm{REC}_t = \gamma_0 + \gamma_1 \mathrm{BWSI}_t + \gamma_2 \mathrm{REGD}_t + \varepsilon_t, \qquad \text{(A1)}$$

where REC_t is either MEANREC or BUYSELL (not orthogonal) in month *t*; BWSI_t is Baker and Wurgler's sentiment index (not orthogonal) in month *t*; and REGD_t is a dummy variable for the period of September 2002 – December 2007, which conforms to the period during which the more important regulations—NASD 2711 and NYSE 472—were put in place.

Table A1 reports the results of Regression A1, where Panel 1 corresponds to MEANREC and Panel 2 corresponds to BUYSELL as the dependent variables, respectively.

<< Insert Table A1 >>

As can be seen, in the first test in both panels the coefficient corresponding to BWSI_t is positive and highly significant with Newey-West *t*-values of 3.78 in the case of MEANREC (Panel 1), and 9.09 in the case of BUYSELL (Panel 2). Comparing the results in Table A1 with the results in Table 3 in the text reveals that macroeconomic variables indeed account for some of the correlation between MEANREC and BUYSELL with sentiment. However, this correlation remains significant after accounting for these variables, particularly as regards BUYSELL.

The above coefficients remain significant when the regulations dummy variable, REGD_t, is also included with *t*-values of 2.22 in the case of MEANREC, and 6.73 in the case of BUYSELL. Interestingly, in both cases the coefficient corresponding to REGD is negative and highly significant, which conforms to Barber, Lehavy, McNichols, and Trueman (2006) and Kadan, Madureira, Wang, and Zach's (2009) results, showing that these regulations indeed negatively affect the average recommendation.

Table A1: Preliminary regressions – Recommendation variables and sentiment

The table reports the results of the following regression:

$$\mathrm{REC}_t = \gamma_0 + \gamma_1 \mathrm{BWSI}_t + \gamma_2 \mathrm{REGD}_t + \varepsilon_t,$$

where REC_t is either the MEANREC or BUYSELL variable (not orthogonal to macroeconomic variables) in month *t*; BWSI_t is Baker and Wurgler's sentiment index in month *t* (not orthogonal to macroeconomic variables); and REGD_t is a dummy variable for the NASD 2711 and NYSE 472 regulations' period from September 2002 to December 2007. The data covers the period of November 1993 – December 2007. The first line of each test reports the regression coefficients, while the next line reports the corresponding Newey-West *t*-values (in brackets) with 7 lags. One and two asterisks indicate a two-tail test significance level of 5% and 1%, respectively. SC stands for rejecting the null hypothesis asserting no serial correlation.

1. $\mathrm{MEANREC}_t = \gamma_0 + \gamma_1 \mathrm{BWSI}_t + \gamma_2 \mathrm{REGD}_t + \varepsilon_t$

	γ_0	BWSI_t	REGD_t	Durbin-Watson[1]	R^2/F
1.	-2.2637	0.1699		0.05 (SC)	0.48
	(-96.67**)	(3.77**)			
2.	-2.1379	0.0500	-0.2448	0.18 (SC)	0.90
	(-131.16**)	(2.17*)	(-11.25**)		

2. $\mathrm{BUYSELL}_t = \gamma_0 + \gamma_1 \mathrm{BWSI}_t + \gamma_2 \mathrm{REGD}_t + \varepsilon_t$

	γ_0	BWSI_t	REGD_t	Durbin-Watson[1]	R^2/F
3.	11.9959	12.5195		0.08 (SC)	0.65
	(10.61**)	(9.57**)			
4.	16.9110	7.8353	-9.5635	0.10 (SC)	0.81
	(9.05**)	(6.32**)	(-4.53**)		

[1]The critical values for the Durbin-Watson statistic to reject the null hypothesis asserting no serial correlation at a 5% significance level are d_L=1.74 and d_H=1.76 for the first test in each panel and d_L=1.73 and d_H=1.77 for the second test in each panel.