**Is Herding Spurious or Intentional? Evidence from Analyst Recommendation Revisions and Sentiment**

**Abstract**

Using institutional holdings data for 1993-2015, we investigate whether institutional herding is spurious or intentional by analysing the impact on herding of analyst recommendation revisions and sentiment. In addition to examining their effect separately, we consider the impact of their interaction. Utilising the Sias method, we develop competing hypotheses concerning spurious and intentional herding, an issue of direct interest to fund investors, given the principal-agent relationship inherent in fund management. Results strongly suggest herding is spurious. Analysis of the relationship between herding and subsequent returns, and findings from robustness tests add further support.

*JEL classification:* G0, G23, G40.

*Keywords:* Herding; Sentiment; Analyst recommendation revisions; Institutional investors; Information.

## 1. Introduction

A growing body of literature has investigated the extent and causes of herding by institutional investors. Considerable evidence of herding has emerged (see, for example, Scharfstein and Stein, 1990; Dasgupta et al., 2011; Economou et al., 2015; Gavriilidis et al., 2013; Galariotis et al., 2016a, 2016b; Guney et al., 2017) and a range of possible reasons for herding have been put forward, including reputational reasons, information cascades, correlated information and specific characteristics (e.g. Bikhchandani et al., 1992; Froot et al., 1992). However, as yet there is no consensus as to whether herding arises intentionally (where investors ignore their own information, but instead follow the actions of others, either for reputational reasons or a belief that others are better informed) or is spurious (i.e. it is unintentional; for example, investors may herd if they trade on the basis of similar information sets). Understanding whether herding is intentional or spurious is a matter of concern to investors in funds, since if herding is intentional they may be paying fees which are not justified by the ability of the fund managers.

This paper develops and examines hypotheses in relation to the responses of institutions to two exogenous trading factors, analyst recommendation revisions and investor sentiment, in order to determine whether herding is intentional or spurious. Analyst recommendations are highly valuable to institutional investors, as documented in a number of studies (see, for example, Brennan and Hughes, 1991; Womack, 1996; Ljungqvist et al., 2007). Institutional investors use both buy- and sell-side analyst information as important inputs to their investment decisions. In terms of herding, Chen and Cheng (2006) show that the quarterly change in institutional holdings is positively correlated with consensus analyst recommendations and find that there are more buyer-initiated than seller-initiated trades around favourable recommendations and more seller-initiated than buyer-initiated trades around unfavourable recommendations. Costello and Hall (2011) confirm the results for individual mutual fund portfolios and find that the change in fund holdings is positively correlated with analyst recommendation revisions. Franck and Kerl (2013) document that European mutual funds rely on sell-side analyst forecasts and their holdings in stocks are positively correlated with analyst consensus forecast measures. Another recent study by Brown et al. (2014) shows that mutual funds tend to follow analyst recommendation revisions and herd into stocks with upgrades and herd out of stocks with downgrades.

Similarly, although evidence of the specific relationship between herding and sentiment is limited, there is extensive evidence showing that institutions' trading decisions and, consequently, stock returns are affected by sentiment. In relation to herding, Hwang and Salmon (2006) show that beta herding is positively related to sentiment. Within a broader context, while some studies have suggested that institutions trade counter to individual sentiment (see for example, Brown and Cliff, 2004, 2005 and Schmeling, 2007), there are numerous studies suggesting institutions trade in line with sentiment. For example, Griffin et al. (2011) and Brunnermeier and Nagel (2004) suggest institutions tended to buy technology stocks during the tech bubble. While the results in these studies suggest a relationship between sentiment and trading behaviour for specific time periods or firm types, results from other studies relate herding to irrational psychological biases (see, for example, Dreman, 1979 and Friedman, 1984), suggesting the relationship may be widely applicable. Moreover, DeVault et al. (2019) provide evidence of a correlation between institutions' trades and sentiment, with sentiment not only captured by the Baker and Wurgler (2007) sentiment metric, but also by other market-wide sentiment measures (e.g. consumer confidence indices). As they state "the relations between sentiment metrics, returns, and institutional demand shocks are pervasive" (DeVault et al., 2019, p.987). In addition, Wang (2018) finds evidence consistent with institutional investors being sentiment traders. More generally, Schwarz (2000) argues sentiment is a key factor in influencing decision making, Baddeley et al. (2010) demonstrate that herd behaviour is related to emotion and there is extensive and increasing evidence of a relationship between sentiment and financial decision making[1].

While the impact of analyst revisions and sentiment on institutional herding has been investigated previously, the question of whether responses to these factors suggest herding is spurious or intentional has not been considered. Furthermore, to date no study has examined how the interaction of analyst recommendation revisions and sentiment impacts on herding or the implications of the interaction for determining the drivers of herd behaviour. As discussed below in developing our hypotheses, there are strong reasons for believing that their interaction may affect herding.[2] Examining trading behaviour in relation to these features provides an opportunity to determine whether herding is driven primarily by institutions responding to correlated information relating to analyst revisions or sentiment (spurious herding) or primarily by reputational reasons/beliefs that others are better informed (intentional herding). To this end, we use the Sias (2004) (henceforth, Sias) herding measure to provide insights into the extent and causes of herd behaviour. The Sias measure is derived from using a change in the number of institutions trading a particular stock, rather than the change in percentage of shares held by institutions. As Sias et al. (2006) argue, changes in the number of institutions trading a share is a better predictor of the price impact than changes in the number of shares institutions hold. More importantly, this measure allows us to distinguish between institutions following their own trades and institutions following the trades of others over adjacent periods. Wermers (2001) suggests that institutions can take up to several months to unwind positions and establish

[1] See, for example, Lee et al. (1991), Baker and Wurgler (2006,) Baker, Wurgler and Yuan (2012), Chau et al. (2016) and Altanlar et al. (2019).

[2] It is, of course, possible that rather than there being an interaction effect, there is a mediating effect between the two factors. However, the evidence presented above demonstrating considerable evidence of a direct effect of both analyst revisions and sentiment suggests that the interaction effect is more appropriate. The development of the hypotheses and the results support this view.

new ones in particular stocks to minimise the trading costs. (See also, Chan and Lakonishok, 1993, 1995, Barclay and Warner, 1993 and Chakravarty, 2001). Empirical evidence supports the view that investors may seek to "hide" some aspect of their orders, consistent with phased trading behaviour (see, for example, De Winne and D'Hondt, 2007). Hence, in the absence of new signals, some component of any observed herding across adjacent periods will relate to institutions following their own trades. Therefore, to distinguish between spurious and intentional herding, we need to consider changes not just in total herding, but also in the two components. Thus, use of the Sias measure allows us to provide insights into whether, and when, herding is intentional or spurious.[3]

By examining the impact of both analyst recommendation revisions and sentiment, this study makes three contributions to the literature. First, we develop two sets of competing hypotheses in relation to how herding is affected by analyst recommendation revisions and sentiment: one for situations in which herding is spurious; and the other where it is intentional. By employing the Sias herding measure to test these competing hypotheses we are able to better understand the drivers of apparent herd behaviour. To further differentiate between spurious and intentional herding, we also examine the relation between institutional demand and subsequent returns. Second, given prior findings of asymmetric responses to good and bad news (see, for example, McQueen et al., 1996; Conrad et al., 2002; Mian and Sankaraguruswamy, 2012 and Williams, 2015), we examine whether the extent to which herding is spurious or intentional is affected by the nature of the news (positive or negative). Finally, not only do we provide further evidence on how analyst recommendations and

[3] Information cascades and reputational concerns can be considered to be sources of intentional herding, whereas investigative herding (analysing similar information sets) or trading on the basis of specific stock characteristics or a combination of both are sources of spurious herding. For example, in a recent study Galariotis et al. (2015, p.597) find that "the release of macro information seems to lead to ''spurious'' herding, irrespective of investment style (small vs. big, value vs. growth)".

sentiment impact on institutional herding separately, but, unlike previous studies, we investigate how the interaction of the two factors affects such behaviour. This allows us to draw inferences about which of the two factors is the key driver of herd behaviour.

Our results suggest that in addition to analyst recommendation revisions and sentiment impacting herding separately, the interaction of the two features has a significant influence on herd behaviour. More importantly, examination of results reveals that our hypotheses relating to herding being spurious receive strong support, while there is little to suggest that herding is intentional. Findings in relation to herding and subsequent returns, and robustness tests support this view. Furthermore, we find that there are marked differences in herding behaviour between when the news is positive (analyst upgrades or optimistic sentiment) and when it is negative (analyst downgrades or pessimistic sentiment), with buy herding being stronger for positive signals and sell herding stronger for negative signals.

The remainder of the paper is organised as follows. Section 2 develops our hypotheses, while data and methodology are described in section 3. The main empirical results and robustness tests are presented in section 4, with section 5 providing results examining the relationship between herding and subsequent returns. Section 6 concludes the paper.

## 2. Hypothesis development

In this section we develop hypotheses relating to the impact of (i) analyst recommendation revisions; (ii) high or low sentiment states; and (iii) combinations of analyst recommendation revisions and sentiment states on institutions' herding behaviour. For all of (i) – (iii) we develop competing hypotheses on the basis of (a) spurious and (b) intentional herding. Empirical tests allow us to draw inferences about the drivers of herd behaviour. For both spurious and intentional herding we treat analyst upgrades (downgrades) and optimism (pessimism) as providing buy (sell) signals and no change in analyst recommendations or a mild sentiment state as providing no trading signal.[4,5] We first consider the impact of only one signal, before moving on to consider the impact of both signals together.

### *2.1. Herding and signals from analyst recommendation revisions or sentiment*

We begin by assuming that in period t-1 some institutions buy a particular stock, while others sell. In the absence of a positive (buy) or negative (sell) signal (i.e., no change of analyst revisions or mild sentiment states), the argument discussed previously (e.g., Wermers, 2001 and related references above) that institutions take several months to establish new positions suggests that many of those who bought (sold) stock i in t-1, will do the same in period t. Consider first a situation in which herding is spurious and not the results of intent. Let there be two representative institutions X and Y which hold differing views on how to trade.[6] Further, let buy trading be represented by B and sell by S. In the absence of a positive or negative signal the expected trade behaviour is as in exhibit 1:

**Exhibit 1: Trading in the absence of a positive or negative signal and where herding is spurious (not intentional)**

| Institution | Period t-1 | Period t |
|---|---|---|
| X | B | B |
| Y | S | S |

[4] In referring to a buy, sell or no signal from sentiment, we are not suggesting that the sentiment refers to a specific stock. Rather, we argue that when market-wide sentiment is high (low) the market-wide optimism (pessimism) will be interpreted by at least some institutional investors as a signal that stock prices will rise (fall), leading to a desire to buy (sell). It is, of course, the case that market-wide sentiment may be optimistic while that for a particular stock will be pessimistic. However, the latter may well be driven by information, rather than sentiment and so we use the market-wide measure in empirical analysis.

[5] While it is possible that the mild sentiment state or no analyst revisions provides a signal to investors, we argue that the positive or negative signal resulting from optimism/pessimism or upgrade/downgrade is much stronger and we, therefore, use mild and no revisions as a benchmark against which to compare the impact of the stronger signals.

[6] In practice, the analysis does not require that equal proportions of institutions hold differing views. We use the simplified extreme case to illustrate the development of hypotheses.

In this case both institutions follow their own trades across adjacent periods, while neither institution follows the trades of the other institution. For simplicity, in the remainder of the paper we will refer to institutions following their own trades across adjacent periods as *own-trade* herding and institutions following the trades of others as "*true-herding*".[7]

Now consider the situation where analyst recommendation revisions or sentiment contain a buy or sell signal (and herding remains spurious). For at least some institutions the signal will lead to trading behaviour in period t being different from planned (i.e. for some investors a purchase (sale) in t-1 will not be followed by the previously planned purchase (sale) in period t): some of the institutions who sold (bought) in t-1 and were planning to sell (buy) more in t are likely to alter their plans as a result of the positive (negative) signal. For example, for a positive signal, representative institution Y may choose to buy in period t, while the positive signal reinforces X's decision to buy. As a result *own-trade herding* will be lower than in the case of no signal, whereas *true-herding* will be higher than in the case of no signal: in this case the purchase behaviour of Y in period t is the same as that of X in period t-1 and is captured by *true-herding*. Moreover, the analysis shows that sell side *own-trade herding* (buy side *true-herding*) will be lower (higher). For a negative signal, both X and Y will sell in period t and similar inferences concerning *own-trade herding* and *true-herding* can be drawn. This leads to hypotheses H1S and H2S:

If herding is spurious (driven by correlated information):

H1S: Following a positive or negative signal, *own-trade herding* (*true-herding*) will be lower (higher) than when there is no signal.

[7] It should be noted that referring to one institution following the trades of another institution across periods as *true-herding* does not suggest the existence or otherwise of intent.

H2S: Sell (buy) side trading resulting from *own-trade herding* will be lower for positive (negative) signals than when there is no signal. Buy (sell) side *true-herding* will be higher for positive (negative) signals than when there is no signal.

Next consider the case where herding is intentional and there is no positive or negative trading signal. Again, consider two representative traders, but this time let both follow the signal of the other.[8] The expected trading behaviour is now as shown in exhibit 2:

**Exhibit 2: Trading in the absence of a positive or negative signal and where herding is intentional**

| Institution | Period t-1 | Period t |
|---|---|---|
| X | B | S |
| Y | S | B |

In this case we have *true-herding*, but no *own-trade herding*.

Again, consider behaviour following a positive trading signal from either analyst recommendation revisions or sentiment. For at least some institutions it is likely that they will change behaviour, stop herding intentionally and rather trade on the information contained in the positive signal (this will be especially true where the signal confirms any private information which they already held, but which they were ignoring because they believed others to be better informed). As a result, the positive signal will lead some institutions such as X to buy rather than sell, while Y's decision to buy is confirmed by the positive signal. Consequently, *true-herding* will be lower than in the case of no signal whereas *own-trade herding* will be higher than in the case of no signal: the purchase behaviour of X in period t is the same as X's own behaviour in t-1 and is captured by *own-trade herding*. Moreover, sell side

[8] Again, this is a simplified extreme case to illustrate the argument.

*true-herding* (buy side *own-trade herding*) will be lower (higher). A similar argument applies to a negative signal. This leads us to alternative hypotheses for intentional herding:

If herding is intentional:

H1I: Following a positive or negative signal, *own-trade herding* (*true-herding*) will be higher (lower) than when there is no signal.

H2I: Sell (buy) side *true-herding* will be lower for positive (negative) signals than when there is no signal. Buy (sell) side *own-trade herding* will be higher for positive (negative) signals than when there is no signal.

The two sets of alternative hypotheses H1 and H2 will be tested separately for analyst recommendation revisions and sentiment states.[9]

*2.2 Herding and the interaction between analyst recommendation revisions and investor sentiment*

Investigating the impact of the interaction of analyst recommendation revisions and sentiment on the herding components requires distinguishing between situations in which the two factors provide consistent buy/sell signals (upgrades (downgrades) and optimism (pessimism)) and those in which the two signals are contradictory (upgrades (downgrades) and pessimism (optimism)).[10] When the two signals are consistent the arguments which led to the

[9] In principle it is possible that all institutions trade in the same direction in a period. Such a case would make inferences about whether herding is spurious or intentional much more complex. However, examples of such cases are rare: across all time periods less than 0.07% (0.45%) of the cases involve all institutions buying (selling) in the same period. As such, our conclusions on spurious or intentional herding are not materially affected by the extreme cases.

[10] If analyst recommendation revisions and sentiment are highly correlated (for example, if upgrades are concentrated in optimistic sentiment periods) then examining interactions would be of little value. Evidence in table 1 panel B below demonstrates that this is not the case, with the direction of analyst recommendation revisions not strongly related to sentiment.

development of the above hypotheses will again be relevant. However, we expect the hypothesised behaviour to be strengthened for periods where the two signals are consistent (i.e. upgrades during optimistic periods and downgrades during pessimistic periods). This leads to H3S, H4S, H3I and H4I;

For spurious herding:

H3S: In periods characterised by optimism and upgrades (pessimism and downgrades), *own-trade herding* will be lower and *true-herding* will be higher than for combinations of one positive (negative) signal and one no signal, i.e. no revision or mild sentiment.

H4S: Sell (buy) side *own-trade herding* will be lower for upgrades (downgrades) in the presence of optimism (pessimism) than for one positive (negative) signal and one no signal. Buy (sell) side *true-herding* will be higher for upgrades (downgrades) in the presence of optimistic (pessimistic) sentiment than for one positive (negative) signal and one no signal.

For intentional herding:

H3I: In periods characterised by optimism and upgrades (pessimism and downgrades), *own-trade herding* will be higher and *true-herding* will be lower than for combinations of one positive (negative) signal and one no signal.

H4I: Sell (buy) side *true-herding* will be lower for upgrades (downgrades) in the presence of optimism (pessimism) than for one positive (negative) signal and one no signal. Buy (sell) side *own-trade herding* will be higher for upgrades (downgrades) in the presence of optimistic (pessimistic) sentiment than for one positive (negative) signal and one no signal.

In summary, we have developed 4 hypotheses relating to situations where herding is spurious and 4 alternative hypotheses relating to intentional herding. By examining these competing hypotheses we are able to determine the extent to which herding is spurious or intentional.[11]

## 3. Data and methodology

### *3.1. Stock market and stock recommendation data*

The stock recommendation data is obtained from Thomson Financial Institutional Brokers Estimate (I/B/E/S) U.S. All common stocks (share codes 10 and 11) listed on the NYSE, AMEX and NASDAQ are from the Centre for Research in Security Prices (CRSP). Analyst recommendation data is available from November 1993. Hence, our sample period is from December 1993 to December 2015. We sort the original data so that higher ratings represent more favourable recommendations (e.g. 5 corresponds to strong buy and 1 corresponds to strong sell). We follow prior literature to apply several selection criteria on the recommendation data (see, for example, Jegadeesh and Kim, 2006; Loh and Stulz, 2011) and adopt the following:

(i) A rating revision is included if the rating has been revised by the same analyst to "upgrade, downgrade, or no change" within 12 months and has not been stopped by the broker (in the I/B/E/S Stopped File) (e.g. Ljungquist et al., 2009).

(ii) Observations where analysts are coded as anonymous by I/B/E/S or where they are initiations or re-initiations are not included, since it is not possible to track recommendation revisions.

(iii) There should be at least one analyst issuing a recommendation for the stock during the sample period.

Our study uses recommendation revisions instead of recommendation levels, since prior

[11] In the above discussion we have not developed formal hypotheses for situations where the two signals (analyst revisions and sentiment) are contradictory, since it is not clear whether the two signals will, in effect, cancel each other out, or whether one of the signals will dominate. While formal hypotheses are not proposed, for completeness we present and discuss results in relation to contradictory signals in the results section.

studies suggest that revisions are more informative (e.g. Boni and Womack, 2006; Jegadeesh and Kim, 2010) and in light of our focus on positive or negative signals. To measure the consensus recommendation revision for a particular stock for a given period, we follow Jegadeesh et al. (2004). We first calculate the consensus recommendation levels for the current and prior periods. The current consensus recommendation level is the mean of all outstanding recommendations for a given stock and only the most recent recommendation issued within the last 12 months for a given analyst is included. The consensus recommendation revision is computed as the difference between the current consensus recommendation level from t-4 to t and the prior level from t-5 to t-1. As a result, the consensus recommendation revisions range between -4 (strong buy to strong sell) and +4 (strong sell to strong buy). If the revision of a particular stock is greater (less) than zero, the stock is classified as an upgrade (downgrade), with the rest being "no change".[12,13] Panel A of table 1 summarises the number of consensus recommendation revisions based on their sign. Our sample contains 159,734 consensus recommendation revisions in total. There are 38,023 stocks with consensus upgrades (24% of the sample), 79,440 (50%) with no change and 42,271 (26%) with consensus downgrades.

### *3.2. Investor sentiment*

Baker and Wurgler's (2006, 2007) monthly investor sentiment index is employed as a proxy for investor sentiment.[14,15] The index is constructed based on six proxies: trading

[12]Henceforth, we refer to consensus upgrades, consensus downgrades or consensus no change, as upgrades, downgrades or no change respectively.

[13]An alternative definition of consensus revision is used to examine the sensitivity of the results, with results reported in section 4.5.

[14] The data is obtained from Jeffrey Wurgler's website.

[15] We also use the Consumer Confidence index as an alternative measure of investor sentiment in our study. The results remain qualitatively similar and are reported in the robustness tests.

volume, the dividend premium, the closed-end fund discount, the number and first-day returns on IPOs and the equity share in new issues. To mitigate the effect of macroeconomic conditions, they regress each variable on 6 macroeconomic indicators: growth in industrial production, real growth in durable, nondurable and service consumptions, growth in employment and an NBER recession indicator. The residuals from this regression are used as the sentiment proxy. Since institutional ownership is based on quarterly holdings, we calculate the quarterly investor sentiment as the average of the monthly investor sentiment over the quarter. Specifically, an equal weight is given to the prior month and to months 2 and 3 prior to the current month. We next identify optimistic (pessimistic) sentiment periods as quarters when the investor sentiment measure is in the top (bottom) 30% of the time-series values, with the rest being "mild".

Table 1 panel B shows the split between the three sentiment states by type of revision (upgrade, no change and downgrade) and demonstrates a relatively even distribution of revisions across sentiment states. For example, 29% of upgrades occur during optimistic periods, 39% during mild states and 32% during pessimistic periods.

### *3.3. Institutional ownership*

Institutional investor's quarterly holdings are obtained from Thomson-Reuters institutional holdings database, which is based on institutional investors' 13(f) filings with the Securities and Exchange Commission (SEC).[16] The stock market and institutional ownership data used span from September 1993 through December 2015. The institutional ownership of a stock is measured as the number of shares held by institutional investors scaled by the number of shares outstanding at the end of each quarter. We follow Sias (2004) to apply several selection criteria

[16] It is required by the SEC that institutional investors with $100 million or more in assets under management file a Form 13F to report all equity positions greater than 10,000 shares or $200,000 in market value within 45 days of the end of the calendar quarter.

to the institutional data. First, an institutional investor must hold at least one stock at both the beginning and the end of the quarter. In addition, we limit our sample to securities traded by at least five institutional investors, since Sias (2004) and Wermers (1999) suggest that only two or three institutions trading in the same direction does not constitute herding.

**Table 1**
Descriptive statistics.
This table shows descriptive statistics for consensus recommendation revisions (Panel A), the number of recommendation revisions under each sentiment group (Panel B), the number of institutional investors (Panel C), and the number of stocks traded by institutional investors (Panel D). The current consensus recommendation level is the mean of all outstanding recommendations for a given stock. Only the most recent recommendation which is issued within the last 12 months for a given analyst is included and the consensus recommendation revision is the difference between the current and the prior recommendation levels. For each quarter between December 1993 and December 2015 we calculate the number of institutions, the number of stocks traded by at least 1, 5, 10, 20 and 50 institutional investors. The table reports the time-series averages of these values for the whole sample period and every 20 quarters.

Panel A. Consensus recommendation revision categories

| Consensus Recommendation Revision | Frequency | Percentage |
|---|---|---|
| Upgrade | 38,023 | 23.80% |
| No change | 79,440 | 49.73% |
| Downgrade | 42,271 | 26.46% |

Panel B. Consensus recommendation revision and investor sentiment categories

| | Optimism | Mild | Pessimism |
|---|---|---|---|
| Upgrade | 11,165 | 14,872 | 11,986 |
| No change | 26,243 | 31,535 | 21,662 |
| Downgrade | 12,676 | 15,667 | 13,928 |

Panel C. Number of institutional investors

| Year/quarter | 1993-2015 average | 1993/Q4 | 1998/Q4 | 2003/Q4 | 2008/Q4 | 2015/Q4 |
|---|---|---|---|---|---|---|
| No. of Institutions in database | 2,194 | 1,132 | 1,568 | 2,002 | 2,962 | 3,305 |

Panel D. No. of stocks traded by institutions

| | | | | | | |
|---|---|---|---|---|---|---|
| ≥5 institutions | 6,972 | 4,787 | 5,436 | 7,100 | 8,334 | 9,205 |

Panels C and D in table 1 present summary statistics for the institutional data used in the study. Panel C reports the total number of institutional investors. The first column presents the times-series average across all 89 quarters and the other columns report the results every five years. On average there are 2,194 institutions trading. As seen in panel C, the number of institutions increases steadily over the sample period from a low of 1,132 in 1993 to a high of 3,305 in 2015. Panel D reports the number of stocks traded per quarter by at least 5 institutions. As in panel C, the first column reports the average quarterly figure across the sample period, while the remaining columns present figures for each of the listed quarters. On average, the number of stocks traded by institutional investors has increased dramatically over time. The figures are in line with those in Sias (2004).

*3.4. Herding measure*

In empirical work on herding, the Lakonishok et al. (1992) (henceforth LSV) herding measure has been widely used (see, for example, Grinblatt et al., 1995; Wermers, 1999). However, while the LSV model has been shown to be of importance in investigating herding, it has two features that are not suitable for this study. First, as Sias (2004) points out, the LSV measure only indirectly tests for cross-sectional temporal dependence in institutional demand. Second, it cannot distinguish institutional investors who follow their own trades from those who follow the trades of others. Given our hypotheses, such a distinction is important in this study. Sias (2004) proposes an alternative measure which quantifies the extent to which institutions follow each other's trades over adjacent periods. He argues that the key difference is the LSV measure indirectly tests for cross-sectional temporal dependence by recognising behaviour within a period, whereas he directly tests whether institutions follow their own trades or the trades of others over adjacent periods. For our analysis and hypotheses the Sias measure is superior and we, therefore, employ his method in our investigation of herding.[17]

At the beginning and end of each quarter, each institutional investor's position is calculated for each security as a fraction of the security's shares outstanding. We classify an institutional investor as a buyer if ownership of the investor in the security increases and a seller if ownership decreases. To analyse institutional herding, we begin by estimating a cross-sectional regression across K securities:

$$\Delta_{k,t} = \beta_t \Delta_{k,t-1} + \varepsilon_{k,t} \quad (1)$$

Where $\Delta_{k,t}$ is the standardised fraction of institutions buying security k in the current quarter

[17] The Sias model has been widely used in past studies (see, for example, Choi and Sias, 2009; Holmes et al., 2013).

t, $\Delta_{k,t-1}$ is the standardised fraction of institutions buying security k in quarter t-1 and $\varepsilon_{k,t}$ is a zero mean error term. The coefficient $\beta_t$ is the cross-sectional correlation between institutional demand in the current quarter and institutional demand in the previous quarter and it measures the extent to which institutional investors herd into the same security from the last quarter to the current quarter. The level of Sias herding is calculated as the time-series average of the coefficient β. The coefficient $\beta_t$ consists of two components, institutional investors following their own trades (*own-trade herding*) and institutional investors following the trades of other institutional investors (*true-herding*). Specifically,

$$\begin{aligned}\beta_t &= \rho(\Delta_{k,t}, \Delta_{k,t-1}) \\ &= \left[\frac{1}{(K-1)\sigma(Raw\Delta_{k,t})\sigma(Raw\Delta_{k,t-1})}\right] \\ &\times \sum_{k=1}^{K}\left[\sum_{n=1}^{N_{k,t}} \frac{(D_{n,k,t}-\overline{Raw\Delta_t})(D_{n,k,t-1}-\overline{Raw\Delta_{t-1}})}{N_{k,t}N_{k,t-1}}\right] \\ &+ \left[\frac{1}{(K-1)\sigma(Raw\Delta_{k,t})\sigma(Raw\Delta_{k,t-1})}\right] \\ &\times \sum_{k=1}^{K}\left[\sum_{n=1}^{N_{k,t}} \sum_{m=1,m\neq n}^{N_{k,t-1}} \frac{(D_{n,k,t}-\overline{Raw\Delta_t})(D_{m,k,t-1}-\overline{Raw\Delta_{t-1}})}{N_{k,t}N_{k,t-1}}\right]\end{aligned} \tag{2}$$

where K is the number of securities, D is a dummy variable, which equals one (zero) if trader n is a buyer (seller) of security k in quarter t, $\mathrm{Raw}\Delta_{k,t}$ is the raw fraction of the number of institutions buying security k during quarter t, $\sigma(\mathrm{Raw}\Delta_{k,t})$ is its cross-sectional standard deviation across K securities, $\overline{\mathrm{Raw}\Delta_t}$ is the cross-sectional mean average of the raw fraction of the number of institutions buying in quarter t, $N_{k,t}$ is the number of institutional traders trading security k during quarter t, $D_{m,k,t-1}$ is a dummy variable which equals 1 if trader m (m≠n) is a buyer of security k during quarter t-1. All other lag variables are defined similarly. The first multiplicative term in Eq. (2) represents *own-trade herding* and the second *true-herding*.

Following a number of previous studies (e.g. Grinblatt et al., 1995; Wermers, 1999; Wylie, 2005), we further analyse buy herding (following into securities) and sell herding (following out of securities) to examine whether institutions buy or sell stocks when herding, where in Eq. (1) buy herding is measured as institutions that bought the security k in the last quarter t-1 ($Raw_{k,t-1}$>0.5) and sell herding is measured as institutions that sold security k in the last quarter t-1 ($Raw_{k,t-1}$<0.5).

## 4. Empirical analysis

### *4.1. Analyst recommendation revisions and institutional herding*

We begin the analysis by examining the relationship between analyst recommendation revisions and institutional herding. Recall that for both analyst recommendation revisions and sentiment H1S (H1I) hypothesised that *own-trade herding* will be lower (higher) and *true-herding* will be higher (lower) than when there is no signal. Table 2 reports the results for institutional herding across analyst recommendation revision groups for cases where securities are traded by at least 5 institutions. Panel A shows results for total herding and panels B and C relate to buy and sell herding respectively. Within each panel the first row shows the time-series average of the coefficient β and the next two rows show the components of β, relating to *own-trade herding* (institutions following their own trades) and *true-herding* (institutions following the trades of others). The first column in the table reports the time-series averages and associated t-statistics for all stocks, with the next three columns reporting results relating to upgrade, no change and downgrade stocks. The final three columns relate to differences between the three revision categories.

**Table 2**

Analyst recommendations and institutional herding.

This table presents the results for all herding measures (total correlation, contribution of buy and contribution of sell) under all stocks sample and different analyst recommendation revision samples (upgrades, no change and downgrades). The Sias measure is the cross-sectional correlation in adjacent periods. The correlation is then partitioned into two parts, cross-sectional correlation due to own-trade herding (funds following their own trades) and true-herding (due to funds following the trades of others) as defined in equation (2). The total correlation and two partitions are further divided into two parts, buy herding (institutions buy in quarter t-1) and sell herding (institutions sell in quarter t-1). The consensus recommendation revision is the difference between the current and the prior recommendation levels. The current consensus recommendation level is the mean of all outstanding recommendations for a given stock and only the most recent recommendation within the last 12 months for a given analyst is included. The consensus upgrades, downgrades and no change are defined as the value of the consensus revision is bigger, smaller and equal to zero, respectively. The t-statistics are calculated using Newey-West (1987) standard errors. Corresponding t-statistics are reported in parentheses and asterisks refer to different significance levels: *** (1%), ** (5%), * (10%).

| | All | Upgrade | No change | Downgrade | Up.- No change | Down.- No change | Up. – Down. |
|---|---|---|---|---|---|---|---|
| **Panel A. Total cross-sectional correlation** | | | | | | | |
| Average coefficient | 0.3431 | 0.3566 | 0.3264 | 0.3655 | 0.0302 | 0.0391 | -0.0089 |
| | (43.66)*** | (38.36)*** | (36.11)*** | (38.60)*** | (3.06)*** | (4.48)*** | (-0.89) |
| Own-trade herding | 0.0669 | 0.0572 | 0.0768 | 0.0532 | -0.0196 | -0.0236 | 0.0040 |
| | (4.76)*** | (3.89)*** | (5.14)*** | (4.61)*** | (11.84)*** | (-5.18)*** | (0.44) |
| True-herding | 0.2762 | 0.2994 | 0.2495 | 0.3123 | 0.0499 | 0.0628 | -0.0129 |
| | (17.44)*** | (18.05)*** | (15.03)*** | (19.18)*** | (4.87)*** | (7.72)*** | (-1.22) |
| **Panel B. Contribution of Buy** | | | | | | | |
| Average coefficient | 0.1782 | 0.1905 | 0.1768 | 0.1702 | 0.0137 | -0.0066 | 0.0203 |
| | (22.51)*** | (21.61)*** | (21.04)*** | (22.21)*** | (2.47)** | (-1.40) | (2.12)** |
| Own-trade herding | 0.0231 | 0.0183 | 0.0286 | 0.0162 | -0.0103 | -0.0124 | 0.0021 |
| | (12.68)*** | (10.75)*** | (13.44)*** | (10.60)*** | (-9.12)*** | (-11.16)*** | (1.99)** |
| True-herding | 0.1551 | 0.1722 | 0.1482 | 0.1540 | 0.0240 | 0.0058 | 0.0182 |
| | (22.40)*** | (21.61)*** | (20.31)*** | (21.94)*** | (4.20)*** | (1.31) | (1.69)* |
| **Panel C. Contribution of Sell** | | | | | | | |
| Average coefficient | 0.1649 | 0.1661 | 0.1495 | 0.1954 | 0.0166 | 0.0459 | -0.0293 |
| | (25.87)*** | (20.44)*** | (22.52)*** | (28.24)*** | (2.85)*** | (8.05)*** | (-1.98)** |
| Own-trade herding | 0.0438 | 0.0389 | 0.0482 | 0.0370 | -0.0093 | -0.0112 | 0.0019 |
| | (3.01)*** | (2.61)*** | (3.15)*** | (3.16)*** | (-9.64)*** | (-2.32)** | (0.71) |
| True-herding | 0.1211 | 0.1272 | 0.1013 | 0.1584 | 0.0259 | 0.0571 | -0.0312 |
| | (10.27)*** | (10.51)*** | (8.40)*** | (12.99)*** | (4.26)*** | (12.60)*** | (-2.01)** |

As reported in the first row of panel A, the unconditional β for all stocks, stocks with an upgrade, no change and downgrade are all significant, with estimates of 0.3431, 0.3566, 0.3264 and 0.3655 respectively.[18] While these figures are more than twice as large as those of Sias (2004), this is not surprising since our sample is restricted to stocks with analyst recommendations available. Moreover, the results are in line with Choi and Sias (2009) who find an equivalent estimate of 0.4049. Our results provide strong evidence that herding takes place for stocks with analyst recommendations available during the sample period. *Own-trade*

[18] From the final three columns of the first row of panel A it can be seen that total herding is greater for an upgrade or downgrade than for no change, but there is no statistical difference between upgrades and downgrades.

*herding* accounts for only 19.5% of total herding (0.0669/0.3431) for all stocks. While, *own-trade herding* is a much smaller part of total herding across all analyst revision categories, it varies markedly, with it representing 16.0% for upgrades, 23.5% for no change and only 14.6% for downgrades. Examination of columns 5 and 6 shows that for both upgrades and downgrades, the level of *own-trade herding* is significantly lower than when there is no change in analyst recommendations. This is consistent with H1S and inconsistent with H1I. Similarly, the level of *true-herding* is significantly higher for both upgrades and downgrades compared to no change, again consistent (inconsistent) with H1S (H1I). Thus, evidence in relation to the first pair of alternative hypotheses suggests that herding is spurious rather than intentional. The final column of panel A shows that differences between upgrades and downgrades are not statistically significant, indicating that the sign of a signal does not affect the level of herding or its components.

Results in panels B and C allow us to test hypotheses H2S and H2I. As can be seen from the first column of panel B (C), buy (sell) herding is estimated to be a significant 0.1782 (0.1649). In both cases, *true-herding* contributes a significant portion of herding, suggesting strong evidence of institutions following the trades of others. Once again, results suggest herding is spurious, rather than intentional: as panel B, columns 5 and 6, show, buy side trading resulting from *own-trade herding* is a significant 0.0124 lower for downgrades compared to no signal, while for buy side *true-herding* it is a significant 0.0240 higher for upgrades than for no change; similarly, results in panel C reveal sell side *own-trade herding* (*true-herding*) is a significant 0.0093 (0.0571) lower (higher) for upgrades (downgrades) than when there is no analyst revision.

The final column demonstrates that there is a significant difference in both buy and sell herding between upgrades and downgrades. To illustrate, it can be seen from panel B that buy herding for upgrades and downgrades is estimated to be a significant 0.1905 and 0.1702, respectively, with the difference being significant at the 5% level. The evidence suggests that institutions herd more strongly to buy stocks with upgrades than stocks with downgrades. The results from the two components of β as shown in the last two rows of panel B reveal that stronger buy herding for upgrades is driven by following both their own trades and the trades of others. In panel C, the β for sell herding for upgrade (downgrade) stocks is a significant 0.1661 (0.1954), with the difference again being significant at the 5% level. The evidence suggests that institutions herd more strongly to sell stocks with downgrades than those with upgrades. In addition, it can be seen from the last row of panel C that there is a significant difference between upgrade and downgrade stocks, for *true-herding*, with this component being higher for downgrades than upgrades. The results suggest that stronger sell herding for downgrade stocks compared to upgrade stocks mostly comes from following the trades of others. Overall the results in table 2 provide strong evidence to support HS1 and HS2 and reject HI1 and HI2, consistent with herding being spurious rather than intentional.

### *4.2. Investor sentiment and institutional herding*

We next examine the relation between investor sentiment and institutional herding, by partitioning the time-series estimates of β into three groups representing optimism, mild sentiment and pessimism and then taking the time-series average of the coefficient β in each sentiment group. Hypotheses H1S, H1I, H2S and H2I are again relevant. Table 3 presents results for tests of these hypotheses, with the structure of the table the same as in table 2, except that results for all are not repeated here (i.e. the first column of table 2 is not shown in table 3).

As was the case for analyst revisions, the unconditional β for stocks traded during optimistic, mild and pessimistic sentiment periods are all significant, with estimates of 0.3689, 0.3321and 0.3294 respectively (panel A first row). While the total level of herding is significantly larger during optimistic periods, compared to the other two groups, the difference between optimistic and mild is only significant at the 10% level and the difference between pessimistic and mild states is insignificantly different from zero. However, while differences in total herding are relatively small, the β coefficients mask large differences in the component parts across sentiment states. For example, *own-trade herding* accounts for only 7.8% (0.0256/0.3294) of herding during pessimistic periods, but the comparable figures are 15.7% for optimism and 31.8% for the mild state. For both optimistic and pessimistic states, the level of *own-trade herding* is lower than for the mild state, again consistent with H1S (and inconsistent with H1I), although the difference is only significant for the pessimistic state. Furthermore, the level of *true-herding* is significantly higher for both optimistic and pessimistic states compared to mild states, again consistent (inconsistent) with H1S (H1I). These results are in line with the findings for analyst recommendation revisions, again suggesting that herding is spurious rather than intentional. The final column of panel A shows that differences between optimism and pessimism are statistically significant for total herding, but that this is driven entirely by *own-trade herding,* with the differences for *true-herding* being insignificantly different from zero.

Again, results in panels B and C suggest herding is spurious, rather than intentional: buy side trading resulting from *own-trade herding* (*true-herding*) is a significant 0.0079 (0.0469) lower (higher) for pessimism (optimism) compared to mild periods (panel B); while sell side *own-trade herding* (*true-herding*) is a significant 0.0596 (0.0571) lower (higher) for optimism (pessimism) compared to mild periods (panel C).

**Table 3**

Investor sentiment and institutional herding.

This table presents the results for all herding measures (total correlation, contribution of buy and contribution of sell) under full-sample period and different sentiment periods (optimism, mild and pessimism). The Sias measure is the cross-sectional correlation in adjacent periods. The correlation is then partitioned into two parts, cross-sectional correlation due to own-trade herding (funds following their own trades) and due to true-herding (funds following the trades of others) as defined in equation (2). The total correlation and two partitions are further divided into two parts, buy herding (institutions buy in quarter t-1) and sell herding (institutions sell in quarter t-1). The Baker and Wurgler's (2007) sentiment index is used to identify optimistic, mild and pessimistic investor sentiment quarters. The quarterly investor sentiment is calculated as the average of the monthly investor sentiment proxy over the quarter and optimistic (pessimistic) sentiment periods are defined when the value in that quarter belongs to the top (bottom) 30% of the time-series value, otherwise mild. The t-statistics are calculated using Newey-West (1987) standard errors. Corresponding t-statistics are reported in parentheses and asterisks refer to different significance levels: *** (1%), ** (5%), * (10%).

| | Optimistic | Mild | Pessimistic | Opt.- Mild. | Pess.- Mild. | Opt.- Pess. |
|---|---|---|---|---|---|---|
| Panel A. Total cross-sectional correlation | | | | | | |
| Average coefficient | 0.3689 | 0.3321 | 0.3294 | 0.0368 | -0.0027 | 0.0395 |
| | (23.17)*** | (30.73)*** | (23.63)*** | (1.92)* | (-0.05) | (1.97)** |
| Own-trade herding | 0.0581 | 0.1055 | 0.0256 | -0.0474 | -0.0799 | 0.0325 |
| | (13.31)*** | (3.03)*** | (8.06)*** | (-1.34) | (-2.28)** | (7.70)*** |
| True-herding | 0.3108 | 0.2266 | 0.3038 | 0.0842 | 0.0772 | 0.0070 |
| | (18.53)*** | (6.33)*** | (24.20)*** | (2.12)** | (2.08)** | (0.24) |
| Panel B. Contribution of Buy | | | | | | |
| Average coefficient | 0.2154 | 0.1563 | 0.1685 | 0.0591 | 0.0122 | 0.0469 |
| | (14.91)*** | (12.84)*** | (13.50)*** | (3.09)** | (0.78) | (1.99)** |
| Own-trade herding | 0.0339 | 0.0217 | 0.0138 | 0.0122 | -0.0079 | 0.0201 |
| | (10.84)*** | (7.43)*** | (6.81)*** | (2.88)*** | (-2.16)** | (5.21)*** |
| True-herding | 0.1815 | 0.1346 | 0.1547 | 0.0469 | 0.0201 | 0.0268 |
| | (13.27)*** | (13.15)*** | (14.03)*** | (2.70)*** | (1.42) | (0.97) |
| Panel C. Contribution of Sell | | | | | | |
| Average coefficient | 0.1535 | 0.1758 | 0.1609 | -0.0223 | -0.0149 | -0.0074 |
| | (16.99)*** | (14.66)*** | (14.85)*** | (-1.41) | (-0.90) | (-0.58) |
| Own-trade herding | 0.0242 | 0.0838 | 0.0118 | -0.0596 | -0.0720 | 0.0124 |
| | (11.98)*** | (2.34)** | (8.05)*** | (-1.69)* | (-2.01)** | (6.54)*** |
| True-herding | 0.1293 | 0.0920 | 0.1491 | 0.0373 | 0.0571 | -0.0198 |
| | (15.05)*** | (3.31)*** | (14.47)*** | (1.31) | (1.94)* | (-1.80)* |

The final column of table 3 demonstrates that there is a significant difference in buy herding between optimistic and pessimistic periods. However, unlike the case for analyst recommendation revisions, the difference between the two extreme sentiment states is mainly driven by *own-trade herding* rather than *true-herding*. This suggests that institutions are more confident to herd to buy stocks in the presence of optimistic sentiment than pessimistic sentiment. Nonetheless, results are in line with institutions herding more strongly to buy stocks during periods of optimism compared to pessimistic periods. The result is in line with DeVault et al. (2019) who find that institutions are indeed sentiment traders. In contrast, while the estimated β coefficient for sell herding is marginally higher under pessimism, the difference is not statistically significant. However, the final column of the second and third rows of panel C show that *own-trade herding* is higher under optimism, while *true-herding* is higher under pessimism, with both differences being significant. Hence, the results are similar to the findings relating to analyst recommendation revisions in that there is stronger sell herding for periods of pessimism compared to periods of optimism and this is driven by institutions following the trades of others.

### *4.3. Herding and the interaction between analyst recommendation revisions and investor sentiment*

In this section, we investigate how analyst recommendation revisions and investor sentiment interact in influencing institutional herding. To examine such an interaction, we double sort the data sample on consensus recommendation revisions and investor sentiment. Specifically, during each quarter, we classify a stock as an upgrade or downgrade stock based on its consensus analyst recommendation revision and then estimate the correlation coefficient β and its two components for each of the revision groups in each quarter. We then categorise each quarter as optimistic, mild or pessimistic and compute the time-series average of the correlation coefficient and its two components in different sentiment periods. We examine separately situations where the two signals are consistent (i.e. upgrade and optimism or downgrade and pessimism) and where they are contradictory (i.e. upgrade and pessimism or downgrade and optimism).

**Table 4**

Consistent signals and institutional herding.

This table reports the average levels of the Sias aggregate, buy, and sell herding measures double sorted by investor sentiment and consensus analyst recommendation revisions during the 1993-2015 period. The Sias measure is the cross-sectional correlation in adjacent periods. The correlation is then partitioned into two parts, cross-sectional correlation due to own-trade herding (funds following their own trades) and due to true-herding (funds following the trades of others) as defined in equation (2). The total correlation and two partitions are further divided into two parts, buy herding (institutions buy in quarter t-1) and sell herding (institutions sell in quarter t-1). The consensus recommendation revision is the difference between the current and the prior recommendation levels and the current consensus recommendation level based on the mean of all outstanding recommendations for a given stock, with only the most recent recommendation for a given analyst included. The consensus upgrades or downgrades refer to when the value of the consensus revision is bigger or smaller than zero, respectively. The Baker and Wurgler's (2007) sentiment index is used to identify optimistic, mild and pessimistic investor sentiment quarters. The quarterly investor sentiment is calculated as the average of the monthly investor sentiment proxy over the quarter and optimistic (pessimistic) sentiment periods are defined when the value in that quarter belongs to the top (bottom) 30% of the time-series value, otherwise mild. The t-statistics are calculated using Newey-West (1987) standard errors. Corresponding t-statistics are reported in parentheses and asterisks refer to different significance levels: *** (1%), ** (5%), * (10%).

| | Consistent Signals | | One Positive Signal | | One Negative Signal | | Consistent Positive - One Positive | | Consistent Negative - One Negative | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Up & Opt. (1) | Down & Pess (2) | Up & Mild (3) | No change & Opt. (4) | Down & Mild (5) | No change & Pess. (6) | (7)=(1)-(3) | (8)=(1)-(4) | (9)=(2)-(5) | (10)=(2)-(6) |
| **Panel A. Aggregate trades** | | | | | | | | | | |
| Aggregate herding | 0.3828 | 0.3650 | 0.3560 | 0.3546 | 0.3487 | 0.3133 | 0.0268 | 0.0282 | 0.0163 | 0.0517 |
| | (21.37)*** | (26.32)*** | (28.18)*** | (19.05) | (20.00)*** | (18.03)*** | (1.12) | (1.31) | (0.91) | (1.81)* |
| Contribution of buy | 0.2322 | 0.1701 | 0.1724 | 0.2173 | 0.1500 | 0.1680 | 0.0598 | 0.0149 | 0.0201 | 0.0021 |
| | (14.32)*** | (14.01)*** | (12.30)*** | (16.68)*** | (11.93)*** | (13.12)*** | (2.31)** | (0.71) | (1.31) | (0.31) |
| Contribution of sell | 0.1506 | 0.1949 | 0.1835 | 0.1373 | 0.1988 | 0.1453 | -0.0329 | 0.0133 | -0.0039 | 0.0496 |
| | (11.49)*** | (15.00)*** | (12.43)*** | (13.98)*** | (16.74)*** | (11.13)*** | (-1.45) | (0.68) | (-0.21) | (1.91)* |
| **Panel B. Own-trade herding** | | | | | | | | | | |
| Aggregate herding | 0.0474 | 0.0185 | 0.0966 | 0.0685 | 0.0865 | 0.0334 | -0.0492 | -0.0211 | -0.0680 | -0.0149 |
| | (11.22)*** | (6.15)*** | (7.65)** | (11.80)*** | (8.01)*** | (8.27)*** | (-3.11)*** | (-2.51)** | (-4.31)*** | (-1.89)* |
| Contribution of buy | 0.0294 | 0.0091 | 0.0167 | 0.0415 | 0.0163 | 0.0189 | 0.0127 | -0.0121 | -0.0072 | -0.0098 |
| | (9.00)*** | (5.55)*** | (2.14)** | (11.79)*** | (2.39)** | (6.88)*** | (2.31)** | (-1.96)** | (-1.53) | (-1.63) |
| Contribution of sell | 0.0180 | 0.0094 | 0.0799 | 0.0269 | 0.0702 | 0.0145 | -0.0619 | -0.0089 | -0.0608 | -0.0051 |
| | (10.00)*** | (5.90)*** | (6.92)*** | (11.93)*** | (6.27)*** | (8.28)*** | (-3.02)*** | (-1.91)* | (-3.71)*** | (-1.03) |
| **Panel C. True-herding** | | | | | | | | | | |
| Aggregate herding | 0.3354 | 0.3466 | 0.2594 | 0.2861 | 0.2622 | 0.2799 | 0.0760 | 0.0493 | 0.0844 | 0.0667 |
| | (17.98)*** | (26.21)*** | (11.04)*** | (14.68)*** | (22.11) | (18.07)*** | (3.31)*** | (1.92)* | (3.81)*** | (2.81)*** |
| Contribution of buy | 0.2027 | 0.1611 | 0.1557 | 0.1757 | 0.1337 | 0.1491 | 0.0470 | 0.0270 | 0.0274 | 0.0120 |
| | (13.22)*** | (14.33)*** | (12.40)*** | (11.84)*** | (11.96) | (12.34)*** | (2.33)** | (1.61) | (1.11) | (0.59) |
| Contribution of sell | 0.1327 | 0.1855 | 0.1037 | 0.1103 | 0.1285 | 0.1308 | 0.0290 | 0.0224 | 0.0570 | 0.0547 |
| | (10.68)*** | (14.64)*** | (7.33)*** | (13.93)*** | (10.11) | (12.23)*** | (1.63) | (1.41) | (2.51)** | (2.56)** |

*4.3.1 Herding and consistent buy/sell signals from analyst revisions and sentiment*

Results relating to cases where the two signals are in the same direction (buy or sell) allow us to test hypotheses H3S, H4S, H3I and H4I and are presented in table 4. The table consists of three panels relating to the average value of the β coefficient (panel A), and its two components, *own-trade herding* (panel B) and *true-herding* (panel C). Within each panel the first row relates to the coefficients for buy and sell herding combined and the next two rows relate to the contribution from buy and sell herding respectively. Recall that in this section hypotheses relate to comparing two positive (negative) signals with one positive (negative) signal and one no signal. The table has ten columns. The first (second) column presents results for two positive (negative) signals. In columns 3 and 4 (5 and 6) estimates for cases where there is one positive (negative) and one no signal are presented. The final four columns relate to testing the difference between the consistent signals and the one positive/negative signal and one no signal.

While our hypotheses relate to the two components of herding rather than total herding, for completeness results for the latter are presented in table 4 panel A. For two positive (negative) signals the estimated coefficient for total herding in column 1 (2) is larger than the estimates for only one positive (negative) signal, but the differences are not statistically significant, with one exception (column 10) at the 10% level. Similarly, differences on the buy and sell side are generally insignificant (one exception in each case). However, the results for total herding mask substantial differences in relation to the two herding components, as shown in table 4, panels B and C. The results in the first row of panel B demonstrate that the estimate for *own-trade herding* for two positive (negative) signals is 0.0474 (0.0185), with the estimate being significantly lower than for only one positive (negative) signal and one no change signal, as shown in columns 7 and 8 (9 and 10). Thus, in relation to *own-trade herding* results are consistent with H3S rather than H3I. Similarly, the results relating to *true-herding* in panel C are consistent with the second part of H3S, rather than H3I: the estimates of 0.3354 (for two positive signals) and 0.3466 (for two negative signals) are significantly higher than their one signal/one no signal counterparts.

Investigation of hypotheses H4S and H4I requires examination of the final two rows in table 4, panels B and C. Results in panel B show that in relation to buy side *own-trade herding* the estimate is lower for two negative signals than for one negative and one no signal as hypothesised in H4S. However, the differences are not statistically significant. In contrast, the results for sell side *own-trade herding* are statistically lower for two positive signals than for one positive and one no signal as shown in the columns 7 and 8 of panel B, in line with H4S. Similarly, results in panel C for *true-herding* are broadly consistent with the second part of hypothesis H4S: for buy side herding the estimate for two positive signals is higher than for one positive and one no signal; for sell side herding the estimate for downgrades and pessimism is higher than for one negative and one no signal. In three of the four cases (columns 7 to 10) the differences are statistically significant (the exception being in column 8 for no analyst revision and optimism). In contrast, in no case is the relationship hypothesised in H4I supported.

In summary, for the cases where signals from analyst recommendation revisions and sentiment are of the same sign, the results again support the view that herding is spurious rather than intentional, in line with findings for the two signals separately.

*4.3.2 Herding and contradictory buy/sell signals from analyst recommendation revisions and sentiment*

As explained in footnote 11 in section 2, we have no formal hypotheses relating to situations where the two buy/sell signals (analyst revisions and sentiment) are contradictory. However, for completeness we present estimates of β and its components for these situations and compare these with other scenarios in table 5. While the layout of the table is the same as table 4, the first two columns present results for contradictory signals, column 3 gives those for two no signals (no change in analyst recommendation and mild sentiment state) and columns 4 and 5 are the same as columns 1 and 2 in table 4 (signals of the same sign). The final six columns show differences between contradictory signals and two no signals (columns 6 and 7) and between contradictory signals and two consistent signals (columns 8-11). As previously stated, for completeness we present results relating to total herding in panel A, even though our main concern is with the components of herding. There is no clear pattern of results in panel A. For example, total herding is statistically higher for two positive signals than for the combination of analyst upgrades and pessimism (column 8), but there is no significant difference between two positive signals and downgrades and optimism (column 10) or between two negative signals and the two contradictory scenarios (columns 9 and 11). Turning to the first row of panel B, it is clear that when there is one positive and one negative signal (columns 1 and 2) *own-trade herding* is lower than when there are no signals. This view is consistent with institutions being less confident in following their own trades when there is greater uncertainty (contradictory signals). Furthermore, there are clear similarities in the coefficients for the combinations of: upgrades and pessimism (panel B, column 1) and downgrades and pessimism (column 5); and those for upgrades and optimism (column 4) and downgrades and optimism (column 2). Moreover, there are significant differences between upgrades during optimistic periods (column 4) and those in pessimistic periods (column 1) and between downgrades across the two sentiment states (columns 5 and 2). Similar results hold for the buy and sell side of *own-trade herding*. Taken together, these results suggest that when there are contradictory signals, it is the sentiment state which dominates *own-trade herding* behaviour.

Results in the first row of panel C show *true-herding* being significantly higher when there is one positive and one negative signal than when there is no signal as shown in Columns 6 and 7. However, in this case, the estimated coefficients across the various combinations of analyst

**Table 5**

Contradictory signals and institutional herding.

This table reports the average levels of the Sias aggregate, buy, and sell herding measures double sorted by investor sentiment and consensus analyst recommendation revisions during the 1993-2015 period. The Sias measure is the cross-sectional correlation in adjacent periods. The correlation is then partitioned into two parts, cross-sectional correlation due to own-trade herding (funds following their own trades) and due to true-herding (funds following the trades of others) as defined in equation (2). The total correlation and two partitions are further divided into two parts, buy herding (institutions buy in quarter t-1) and sell herding (institutions sell in quarter t-1). The consensus recommendation revision is the difference between the current and the prior recommendation levels and the current consensus recommendation level based on the mean of all outstanding recommendations for a given stock, with only the most recent recommendation for a given analyst included. The consensus upgrades or downgrades refer to when the value of the consensus revision is bigger or smaller than zero, respectively. The Baker and Wurgler's (2007) sentiment index is used to identify optimistic, mild and pessimistic investor sentiment quarters. The quarterly investor sentiment is calculated as the average of the monthly investor sentiment proxy over the quarter and optimistic (pessimistic) sentiment periods are defined when the value in that quarter belongs to the top (bottom) 30% of the time-series value. The t-statistics are calculated using Newey-West (1987) standard errors. Corresponding t-statistics are reported in parentheses and asterisks refer to different significance levels: *** (1%), ** (5%), * (10%).

| | Contradictory Signals | | No Signal | Consistent Signals | | Contradictory - No Signal | | Contradictory - Consistent | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Up & Pess. | Down & Opt. | No change & Mild | Up & Opt. | Down & Pess | (6) | (7) | (8) | (9) | (10) | (11) |
| | (1) | (2) | (3) | (4) | (5) | =(1)-(3) | =(2)-(3) | =(1)-(4) | =(1)-(5) | =(2)-(4) | =(2)-(5) |
| | | | | | Panel A. Aggregate trades | | | | | | |
| Aggregate | 0.3365 | 0.3806 | 0.3145 | 0.3828 | 0.3650 | 0.0221 | 0.0661 | -0.0463 | -0.0285 | -0.0022 | 0.0156 |
| herding | (18.30)*** | (23.66)*** | (27.63)*** | (21.37)*** | (26.32)*** | (1.23) | (2.11)** | (-1.93)* | (-1.41) | (-0.21) | (0.34) |
| Contribution | 0.1759 | 0.1930 | 0.1522 | 0.2322 | 0.1701 | 0.0237 | 0.0408 | -0.0563 | 0.0058 | -0.0392 | 0.0229 |
| of buy | (12.71)*** | (14.00)*** | (3.17)*** | (14.32)*** | (14.01)*** | (1.31) | (2.18)** | (-2.21)** | (0.63) | (-1.97)** | (1.46) |
| Contribution | 0.1606 | 0.1875 | 0.1623 | 0.1506 | 0.1949 | -0.0017 | 0.0252 | 0.0100 | -0.0343 | 0.0369 | -0.0074 |
| of sell | (12.23)*** | (17.05)*** | (5.42)*** | (11.49)*** | (15.00)*** | (-0.11) | (1.34) | (0.41) | (-1.91)* | (1.92)* | (-0.67) |
| | | | | | Panel B. Own-trade herding | | | | | | |
| Aggregate | 0.0158 | 0.0452 | 0.1173 | 0.0474 | 0.0185 | -0.1015 | -0.0721 | -0.0316 | -0.0027 | -0.0022 | 0.0267 |
| herding | (6.74)*** | (10.37)*** | (12.59)*** | (11.22)*** | (6.15)*** | (-5.19)*** | (-4.01)*** | (-2.71)*** | (-0.31) | (-0.41) | (1.94)* |
| Contribution | 0.0089 | 0.0232 | 0.0262 | 0.0294 | 0.0091 | -0.0173 | -0.0030 | -0.0205 | -0.0002 | -0.0062 | 0.0141 |
| of buy | (5.79)*** | (8.20)*** | (2.38)*** | (9.00)*** | (5.55)*** | (-1.91)* | (-0.67) | (-3.11)*** | (-0.03) | (-0.79) | (1.79)* |
| Contribution | 0.0069 | 0.0219 | 0.0911 | 0.0180 | 0.0094 | -0.0842 | -0.0692 | -0.0111 | -0.0025 | 0.0039 | 0.0125 |
| of sell | (6.89)*** | (10.84)*** | (7.70)*** | (10.00)*** | (5.90)*** | (-4.71)*** | (-3.99)*** | (-2.31)** | (-0.28) | (0.41) | (1.76)* |
| | | | | | Panel C. True-herding | | | | | | |
| Aggregate | 0.3207 | 0.3354 | 0.1972 | 0.3354 | 0.3466 | 0.1235 | 0.1382 | -0.0147 | -0.0259 | 0.0000 | -0.0112 |
| herding | (17.74)*** | (20.02)*** | (12.29)*** | (17.98)*** | (26.21)*** | (5.63)*** | (6.31)*** | (-0.47) | (-1.01) | (0.00) | (-0.41) |
| Contribution | 0.1670 | 0.1698 | 0.1260 | 0.2027 | 0.1611 | 0.0410 | 0.0438 | -0.0357 | 0.0059 | -0.0329 | 0.0087 |
| of buy | (12.83)*** | (13.00)*** | (12.62)*** | (13.22)*** | (14.33)*** | (2.01)** | (3.11)*** | (-1.73)* | (0.72) | (-1.33) | (0.66) |
| Contribution | 0.1537 | 0.1656 | 0.0712 | 0.1327 | 0.1855 | 0.0825 | 0.0944 | 0.0210 | -0.0318 | 0.0329 | -0.0199 |
| of sell | (11.81)*** | (15.43)*** | (8.49)** | (10.68)*** | (14.64)*** | (4.01)*** | (6.01)*** | (1.12) | (-1.34) | (1.32) | (-0.96) |

recommendation revisions and sentiment involving two signals are all extremely similar, suggesting that *true-herding* is largely unaffected by whether there is one positive and one negative or two consistent trading signals. Once again, similar results are found for the buy and sell side herding estimates. Comparisons of results relating to two signals of the same sign and two contradictory signals suggest that there are limited differences for *true-herding*. In contrast, *own-trade herding* appears to be driven more by sentiment than by analyst recommendation revisions.

*4.4. Regression analysis*

To further investigate the interaction of analyst recommendation revisions and investor sentiment on institutional herding, we undertake multivariate regression analysis which takes account of other potential determinants of institutional herding. We follow the time-series regression analysis in Holmes et al. (2013) to regress the quarterly beta ($\beta_t$) (the correlation in institutional demands between two consecutive quarters) from equation (1) and its two components from equation (2) separately on investor sentiment and other potential variables for the samples of all stocks. Specifically, we estimate the following equation:

$$\beta_t = \alpha + b_1 \mathrm{Opt}_{t-1} + b_1 \mathrm{Pess}_{t-1} + \mathrm{c} * \sum Control_{t-1} + \varepsilon_{k,t} \quad (3)$$

Where $\beta_t$ is the estimated quarterly beta from equation (1) (or its component parts from equation 2), Opt (Pess) is a dummy variable which takes the value 1 if the sentiment value is in the top (bottom) 30% of sentiment values and zero otherwise, and the control variables included are quarterly stock market returns (MR) and quarterly market volatility (MVol) (see, for example, Holmes et al., 2013; Popescu and Xu, 2014).

Table 6 reports estimates for aggregate herding (Panel A), buy herding (Panel B) and sell herding (Panel C). The dependent variable in the first column is $\beta_t$, in the second it is that component of $\beta_t$ resulting from *own-trade herding* and in the final column it is the component of $\beta_t$ relating to *true-herding*.[19,20] As shown in panel A of table 6, consistent with spurious herding arguments the coefficients relating to optimism and pessimism are negative (positive) for the component of $\beta_t$ relating to *own-trade herding* (*true-herding*), with three of the four estimates being statistically significant. Thus the results in panel A provide strong support for H1S, even after controlling for other factors which might be expected to impact on herding. While the coefficient for market returns is insignificant in panel A, market volatility has a negative impact on *own-trade herding* and a positive impact on *true-herding*, consistent with greater uncertainty leading to investors following the trades of others to a greater extent. The coefficients on volatility are significant at 10% or higher in all but one case (the unreported result for the component relating to *true-herding* for upgrade stocks).[21] Furthermore, results in panel B (C) of table 6 support the earlier findings for H2S: Buy (sell) side *own-trade herding* is lower for pessimism (optimism), while *true-herding* is higher for optimism (pessimism).[22] In summary, the results from the regression analysis provide support for the earlier findings that herding is spurious rather than intentional.

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[19] It is not possible to undertake the time-series regression analysis with analyst recommendation revisions as independent variables given the panel data nature of the analyst revision observations.

[20] In unreported results we repeat the analysis for stocks with (i) upgrades and (ii) downgrades. In all cases the general pattern of results is the same as for all stocks, with minor exceptions which are discussed in the text. Results are reported in the appendix.

[21] In unreported results, the coefficient of market returns is significantly positive if we only regress beta on market returns, consistent with Popescu and Xu (2014). However, the coefficient of the market returns becomes insignificant after controlling for investor sentiment.

[22] Results for upgrades and downgrades are again consistent in terms of the signs of the coefficients. However, the coefficients relating to pessimism (optimism) for *true* (*own-trade*) *herding* for upgrades (downgrades) are insignificantly different from zero.

**Table 6**
Regression analysis of institutional herding.
This table reports the results of regression analysis for aggregate herding of the quarterly values of beta and the two component parts of beta ('own-trade herding (institutions following their own trades)' and 'true-herding (institutions following the trades of others)') on the following factors: Opt (Pess) is a dummy variable that equals to 1 if the value of the sentiment index in quarter t-1 belongs to the optimistic (pessimistic) group and 0 otherwise. $MR_t$ is quarterly stock market returns and $MVol_t$ is quarterly market volatility. Panel A presents results for aggregate herding. Panels B and C present the results for buy and sell herding, respectively. The number of observations and R-squared are reported at the bottom of each panel. The t-statistics are calculated using Newey-West (1987) standard errors. Corresponding t-statistics are reported in parentheses and asterisks refer to different significance levels: *** (1%), ** (5%), * (10%).

| | Regressand: Beta | Regressand: Beta-component 'Own-trade herding' | Regressand: Beta-component 'True-herding' |
|---|---|---|---|
| | Panel A: Aggregate herding | | |
| Intercept | 0.3317 (21.94)*** | 0.1060 (3.03)*** | 0.2257 (7.88)*** |
| Opt | 0.0354 (1.98)* | -0.0484 (-1.36) | 0.0838 (2.18)** |
| Pess | 0.0019 (0.11) | -0.0798 (-2.28)** | 0.0817 (2.15)** |
| $MR_t$ | -0.0140 (-1.38) | -0.0061 (-0.65) | -0.0079 (-0.61) |
| $MVol_t$ | 0.0128 (1.57) | -0.0226 (-1.78)* | 0.0354 (2.20)** |
| N | 84 | 84 | 84 |
| R-squared | 0.123 | 0.088 | 0.152 |
| | Panel B: Buy herding | | |
| Intercept | 0.1561 (12.87)*** | 0.0217 (7.69)*** | 0.1344 (13.00)*** |
| Opt | 0.0598 (3.19)*** | 0.0127 (3.03)*** | 0.0471 (2.81)*** |
| Pess | 0.0126 (0.71)*** | -0.0082 (-2.26)** | 0.0208 (1.36) |
| $MR_t$ | 0.0098 (1.20) | 0.0028 (1.92)* | 0.0070 (0.96) |
| $MVol_t$ | 0.0093 (1.05) | -0.0012 (-0.86) | 0.0105 (1.23) |
| N | 84 | 84 | 84 |
| R-squared | 0.142 | 0.274 | 0.119 |
| | Panel C: Sell herding | | |
| Intercept | 0.1755 (15.15)*** | 0.0842 (2.34)** | 0.0913 (3.37)*** |
| Opt | -0.0244 (-1.78)* | -0.0611(-1.77)* | 0.0367 (1.30) |
| Pess | -0.0107 (-0.72) | -0.0716 (-1.99)* | 0.0609 (2.12)** |
| $MR_t$ | -0.0237 (-4.34)*** | -0.0088 (-0.95) | -0.0149 (-1.87)* |
| $MVol_t$ | 0.0035 (0.68) | -0.0214 (-1.66)* | 0.0249 (2.53)** |
| N | 84 | 84 | 84 |
| R-squared | 0.214 | 0.087 | 0.152 |

### *4.5. Robustness tests*

To examine the robustness of our findings for hypotheses 1-4 we undertake 5 additional tests using: (a) portfolio analysis of institutional herding and analyst recommendations using a different definition of consensus analyst recommendation revision (table A1);[23] (b) portfolio analysis of institutional herding and sentiment using an alternative sentiment index: consumer confidence index from the Conference Board (table A2); (c) regression analysis of institutional

[23]The alternative definition of consensus revision is that if all analyst revisions are upgrades (downgrades), the consensus revision is upgrade (downgrade).

herding and sentiment using the consumer confidence index (table A3); (d) regression analysis of institutional herding and investor sentiment using a 40/20/40 split for sentiment states (table A4); and (e) regression analysis of institutional herding and investor sentiment in upgrade and downgrade stock samples (tables A5 and A6). In all cases, the results of the robustness tests support our earlier findings.[24]

**5. Herding and subsequent returns**

Prior research has shown that herding can have either a stabilising or destabilising effect on stock prices, depending on the drivers of herding (e.g., Chakravarty, 2001; Grinblatt and Titman, 1989; Sias et al., 2006; Wermers, 1999). Choi and Sias (2009) argue that if institutional herding is driven by information, then a positive correlation is expected between institutional demand and contemporaneous returns, but no inverse relationship with subsequent returns. However, in contrast, they argue that "if herding does not always reflect the process by which information is incorporated into prices, then institutional demand should be positively related to contemporaneous industry returns and *inversely related* to subsequent … returns." (Choi and Sias, 2009, p.484, *emphasis added*). Within the context of our enquiry, the former relates to spurious herding and the latter to intentional herding. Thus, by examining subsequent returns and institutional herding, further evidence on the drivers of herding can be established.

We begin by classifying stocks into categories based on the level of herding in different recommendation revision and sentiment groups. We form a portfolio for each group and then calculate the equally weighted stock returns for the contemporaneous period and for the subsequent twelve quarters. Columns 1 to 6 (7 to 12) in table 7 report the average period returns for institutional herding for stocks with upgrades (downgrades), respectively. In each revision group, the results for the average period returns under optimism and pessimism are presented.

[24] Results of the robustness test are reported in the appendix.

**Table 7**

Institutional herding and subsequent returns.

The table reports the average quarterly raw returns for buy- and sell-herding stocks double sorted by consensus recommendation revisions and investor sentiment during the 1993-2015 period. The portfolio in each group is formed and returns for the portfolio is calculated as the equally weighted of subsequent stock returns. The consensus recommendation revision is the difference between the current and the prior recommendation levels and the current consensus recommendation level is the mean of all outstanding recommendations for a given stock, with only the most recent recommendation for a given analyst included. The consensus upgrade, downgrade and no change are defined as where the value of the consensus revision is bigger, smaller and equal to zero, respectively. The Sias herding measures (buy and sell) are defined in Table 2. The Baker and Wurgler's (2007) sentiment index is used to identify optimistic, mild and pessimistic investor sentiment quarters. The quarterly investor sentiment is calculated as the average of the monthly investor sentiment proxy over the quarter and optimistic (pessimistic) sentiment periods are defined as the value in that quarter belongs to the top (bottom) 30% of the time-series value. Corresponding t-statistics are reported in parentheses and asterisks refer to different significance levels: *** (1%), ** (5%), * (10%).

| | Upgrades | | | | | | Downgrades | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Optimistic | | | Pessimistic | | | Optimistic | | | Pessimistic | | |
| | Buy | Sell | Buy-Sell | Buy | Sell | Buy-Sell | Buy | Sell | Buy-Sell | Buy | Sell | Buy-Sell |
| Quarters | 0.0682 | 0.0215 | 0.0467 | 0.1060 | 0.0897 | 0.0163 | 0.0308 | -0.0401 | 0.0709 | 0.0727 | 0.0740 | -0.0013 |
| t-1 to t | (3.28)*** | (1.05) | (2.33)** | (3.87)*** | (3.40)*** | (0.61) | (1.53) | (-1.82)* | (2.22)** | (2.95)*** | (2.73)*** | (-0.16) |
| Quarter | 0.1191 | 0.0047 | 0.1144 | 0.1255 | 0.0323 | 0.0932 | 0.0653 | -0.0548 | 0.1201 | 0.0959 | 0.0143 | 0.0816 |
| t+1 | (4.06)*** | (0.23) | (3.38)*** | (2.77)*** | (0.90) | (2.51)** | (2.81)*** | (-2.22)** | (3.51)*** | (2.52)** | (0.36) | (2.23)** |
| Quarters | 0.0287 | 0.0301 | -0.0014 | 0.0662 | 0.0409 | 0.0253 | 0.0341 | 0.0423 | -0.0082 | 0.0642 | 0.0758 | -0.0116 |
| t+1 to t+4 | (1.01) | (1.22) | (-0.19) | (2.67)*** | (3.34)*** | (1.48) | (1.34) | (1.33) | (-0.41) | (2.87)*** | (3.36)*** | (-0.31) |
| Quarters | 0.0792 | 0.0807 | -0.0015 | 0.0505 | 0.0972 | -0.0467 | 0.0832 | 0.0943 | -0.0111 | 0.0456 | 0.0474 | -0.0018 |
| t+5 to t+8 | (3.23)*** | (3.01)*** | (-0.20) | (2.93)*** | (2.77)*** | (-2.11)** | (2.87)*** | (3.37)*** | (-0.79) | (2.62)*** | (2.48)** | (-0.23) |
| Quarters | 0.0486 | 0.0411 | 0.0075 | 0.0488 | 0.0503 | -0.0015 | 0.0491 | 0.0490 | 0.0001 | 0.0463 | 0.0566 | -0.0103 |
| t+9 to t+12 | (2.23)** | (2.01)** | (0.61) | (2.33)** | (2.11)** | (-0.15) | (2.17)** | (2.11)** | (0.00) | (2.13)** | (2.32)** | (-0.81) |

The first two columns in each category of investor sentiment in table 7 report the average returns for buy- and sell-herding portfolios over the indicated period, respectively. The third column presents their difference and associated t-statistics. Consistent with Choi and Sias (2009) we focus attention on the differences between returns to buy and sell herding stocks.

As far as upgrade stocks are concerned, the results in columns 1-6 are consistent with institutional demand impacting on prices: for both optimistic and pessimistic sentiment states the difference between returns to buy stocks and sell stocks is positive in quarters t-1 and t, although the difference is only statistically significant in optimistic periods.[25] This positive finding persists in quarter t+1 (significant for both optimism and pessimism) and there is no evidence of significant return reversal in quarters t+1 to t+4. For optimism there is no evidence of return reversal for quarters t=1 through t+12. While there is some reversal in quarters t+5 to t+8 for upgrades in pessimistic periods, the scale of the reversal is small compared to the returns in quarters t-1 to t+1. Furthermore, given that this reversal occurs more than a year after the herding, it is not likely that this is a response to the contemporaneous returns resulting from herding. Overall, the evidence in relation to upgrades is consistent with no inverse relationship, again suggesting herding is driven by information, and, therefore, spurious.

For downgrade stocks a similar pattern emerges: the difference between buy and

[25] Such evidence is also consistent with earlier analysis in tables 4 and 5 that buy herding for upgrade stocks under optimism (consistent positive signals) is much larger than that under the mild state (one positive signal) or under pessimism (one positive, one negative signal), since the herding has a significantly positive impact on contemporaneous returns (4.67% vs 1.63%).

sell stocks in quarters t-1 and t is positive and significant during periods of optimism, but insignificantly different from zero during pessimistic sentiment states. The difference is (marginally) negative. Again, the differences are positive and significant in quarter t+1 for both sentiment states. Moreover, for both optimistic and pessimistic states there is no evidence of significant return reversal for periods ranging from quarter t+1 to t+12. Thus, once again the results are consistent with information driving herding behaviour and herding being spurious rather than intentional, supporting the findings from our earlier analysis.

## 7. Conclusion

In this study we develop and test competing hypotheses to establish whether institutional herding is spurious or intentional by investigating the impact which analyst recommendation revisions and sentiment have on trading behaviour. We consider the impact of these two factors separately and jointly. We use institutional holdings data from 13(f) filings for the period 1993 -2015 and utilise the Sias (2004) approach to distinguish between institutions following their own trades (*own-trade herding*) and institutions following the trades of others (*true-herding*). The issue of whether herding is spurious or intentional is of direct interest to fund investors, given the principal-agent relationship which exists in fund management. Specifically, investors are likely to have concerns about investing in funds of, and fees paid to, fund managers who intentionally follow the actions of others, as this suggests they do not believe they are as well informed as their peers.

The results suggest that not only do analyst recommendation revisions and investor sentiment influence institutional herding separately, but also their interaction has a significant impact on institutional herd behaviour. These findings clearly demonstrate that not only do investors extract information signals from analyst recommendation revisions and sentiment, but also are influenced by how the two signals interact. More importantly, our results provide strong support for the view that herding is spurious rather than intentional: all hypotheses relating to spurious herding receive strong support, while results are inconsistent with the competing hypotheses based on intentional herding. Analysis of the relationship between institutional herding and subsequent returns provides further support for this finding, as do the results from several robustness tests.

In conclusion, our study strongly suggests that institutional herding is driven by investigative herding in which institutions herd as a result of analysing the same sentiment-related or analyst recommendation revision indicators, rather than deliberately following the trades of other institutions which they believe are better informed.

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## APPENDIX

### Table A1

Alternative definition of analyst recommendation revisions and institutional herding.

This table presents the results for all herding measures (total correlation, contribution of buy and contribution of sell) under the all stocks sample and different analyst recommendation revision groups (upgrades, no change and downgrades). The Sias measure is the cross-sectional correlation in adjacent periods. The correlation is then partitioned into two parts, cross-sectional correlation due to own-trade herding (funds following their own trades) and true-herding (due to funds following the trades of others) as defined in equation (2). The total correlation and two partitions are further divided into two parts, buy herding (institutions buy in quarter t-1) and sell herding (institutions sell in quarter t-1). The consensus upgrades or downgrades are defined as all revisions issued by different analysts are upgrade or downgrades otherwise no change. The t-statistics are calculated using Newey-West (1987) standard errors. Corresponding t-statistics are reported in parentheses and asterisks refer to different significance levels: *** (1%), ** (5%), * (10%).

| | Upgrade | No change | Downgrade | Up.- No change | Down.- No change | Up. – Down. |
|---|---|---|---|---|---|---|
| **Panel A. Total cross-sectional correlation** | | | | | | |
| Average coefficient | 0.3413<br>(38.36)*** | 0.3177<br>(36.11)*** | 0.3712<br>(38.60)*** | 0.0236<br>(1.61) | 0.0535<br>(4.91)*** | -0.0299<br>(-1.81)* |
| Own-trade herding | 0.0613<br>(3.89)*** | 0.0768<br>(5.14)*** | 0.0711<br>(4.61)*** | -0.0155<br>(-5.13)*** | -0.0057<br>(-2.11)** | -0.0098<br>(-4.77)*** |
| True-herding | 0.2800<br>(17.66) *** | 0.2409<br>(14.00) *** | 0.3001<br>(18.97) *** | 0.0391<br>(3.11)*** | 0.0592<br>(6.11)*** | -0.0201<br>(-1.31) |
| **Panel B. Contribution of Buy** | | | | | | |
| Average coefficient | 0.1913<br>(21.61)*** | 0.1622<br>(21.04)*** | 0.1633<br>(22.21)*** | 0.0291<br>(4.16)*** | 0.0011<br>(0.89) | 0.0280<br>(3.41)*** |
| Own-trade herding | 0.0203<br>(10.75)*** | 0.0291<br>(13.44)*** | 0.0186<br>(10.60)*** | -0.0088<br>(-7.16)*** | -0.0105<br>(-9.13)*** | 0.0017<br>(1.66)* |
| True-herding | 0.1710<br>(20.33)*** | 0.1331<br>(19.22)*** | 0.1447<br>(20.19)*** | 0.0379<br>(5.31)*** | 0.0116<br>(1.81)* | 0.0263<br>(2.01)** |
| **Panel C. Contribution of Sell** | | | | | | |
| Average coefficient | 0.1500<br>(20.11)*** | 0.1555<br>(23.66)*** | 0.2079<br>(23.19)*** | -0.0055<br>(-1.64) | 0.0524<br>(7.33)*** | -0.0579<br>(-7.43)*** |
| Own-trade herding | 0.0410<br>(2.91)*** | 0.0477<br>(3.21)*** | 0.0525<br>(4.18)*** | -0.0067<br>(-3.61)*** | 0.0048<br>(2.31)** | -0.0115<br>(-3.71)*** |
| True-herding | 0.1090<br>(10.33)*** | 0.1078<br>(11.20)*** | 0.1554<br>(13.81)*** | 0.0012<br>(0.34) | 0.0476<br>(11.30)*** | -0.0464<br>(-6.11)*** |

**Table A2**

Alternative sentiment index and institutional herding.

This table presents the results for all herding measures (total correlation, contribution of buy and contribution of sell) under full-sample period and different sentiment periods (optimism, mild and pessimism). The Sias measure is the cross-sectional correlation in adjacent periods. The correlation is then partitioned into two parts, cross-sectional correlation due to own-trade herding (funds following their own trades) and due to true-herding (funds following the trades of others) as defined in equation (2). The total correlation and two partitions are further divided into two parts, buy herding (institutions buy in quarter t-1) and sell herding (institutions sell in quarter t-1). The consumer confidence index is used to identify optimistic, mild and pessimistic investor sentiment quarters. The quarterly investor sentiment is calculated as the average of the monthly investor sentiment proxy over the quarter and optimistic (pessimistic) sentiment periods are defined when the value in that quarter belongs to the top (bottom) 30% of the time-series value, otherwise mild. The t-statistics are calculated using Newey-West (1987) standard errors. Corresponding t-statistics are reported in parentheses and asterisks refer to different significance levels: *** (1%), ** (5%), * (10%).

| | Optimistic | Mild | Pessimistic | Opt.- Mild. | Pess.- Mild. | Opt.- Pess. |
|---|---|---|---|---|---|---|
| Panel A. Total cross-sectional correlation | | | | | | |
| Average coefficient | 0.3711 | 0.3218 | 0.3299 | 0.0493 | 0.0081 | 0.0412 |
| | (22.17)*** | (28.13)*** | (21.03)*** | (2.13)** | (1.01) | (2.08)** |
| Own-trade herding | 0.0592 | 0.1078 | 0.0311 | -0.0486 | -0.0767 | 0.0281 |
| | (13.31)*** | (3.03)*** | (8.06)*** | (-1.51) | (-2.19)** | (4.63)*** |
| True-herding | 0.3119 | 0.2140 | 0.2988 | 0.0979 | 0.0848 | 0.0131 |
| | (18.17)*** | (6.02)*** | (20.13)*** | (2.71)*** | (2.28)** | (0.44) |
| Panel B. Contribution of Buy | | | | | | |
| Average coefficient | 0.1998 | 0.1499 | 0.1633 | 0.0499 | 0.0134 | 0.0365 |
| | (13.11)*** | (13.28)*** | (14.26)*** | (2.87)** | (0.91) | (1.97)** |
| Own-trade herding | 0.0304 | 0.0236 | 0.0121 | 0.0068 | -0.0115 | 0.0183 |
| | (8.44)*** | (7.22)*** | (5.96)*** | (1.99)** | (-2.69)*** | (4.33)*** |
| True-herding | 0.1694 | 0.1263 | 0.1512 | 0.0431 | 0.0249 | 0.0182 |
| | (12.97)*** | (12.45)*** | (13.87)*** | (2.23)** | (1.53) | (0.79) |
| Panel C. Contribution of Sell | | | | | | |
| Average coefficient | 0.1611 | 0.1682 | 0.1511 | -0.0071 | -0.0171 | 0.0100 |
| | (15.26)*** | (14.23)*** | (13.69)*** | (-1.03) | (-1.42) | (1.01) |
| Own-trade herding | 0.0221 | 0.0812 | 0.0163 | -0.0591 | -0.0649 | 0.0058 |
| | (11.98)*** | (3.69)*** | (8.05)*** | (-1.81)* | (-1.89)* | (4.97)*** |
| True-herding | 0.1390 | 0.0870 | 0.1348 | 0.0520 | 0.0478 | 0.0042 |
| | (13.98)*** | (4.11)*** | (12.87)*** | (1.64) | (1.81)* | (0.72) |

**Table A3**

Alternative sentiment index and regression analysis for institutional herding.

This table reports the results for the regression analysis for aggregate herding of the quarterly values of beta and the two component parts of beta ('own-trade herding (institutions following their own trades)' and 'true-herding (institutions following the trades of others)') on the following factors: Sentiment is measured using consumer confidence index. Opt (Pess) is a dummy variable that equals to 1 if the value of the sentiment index in quarter t-1 belongs to the optimistic (pessimistic) group and 0 otherwise. $MR_t$ is quarterly stock market returns and $MVol_t$ is quarterly market volatility. Panel A presents results for aggregate herding. Panels B and C present the results for buy and sell herding, respectively. The number of observations and R-squared are reported at the bottom of each panel. The t-statistics are calculated using Newey-West (1987) standard errors. Corresponding t-statistics are reported in parentheses and asterisks refer to different significance levels: *** (1%), ** (5%), * (10%).

| | Regressand: beta | Regressand: Beta-component 'Own-trade herding' | Regressand: Beta-component 'True-herding' |
|---|---|---|---|
| | Panel A: Aggregate herding | | |
| Intercept | 0.3333 (28.90)*** | 0.0861 (2.84)*** | 0.2472 (7.73)*** |
| Opt | 0.0431 (2.34)** | -0.0051 (-0.14) | 0.0482 (2.44)** |
| Pess | -0.0132 (-0.74) | -0.0602 (-1.99)** | 0.0470 (2.00)** |
| $MR_t$ | -0.0148 (-1.62) | -0.0059 (-0.65) | -0.0089 (-0.67) |
| $MVol_t$ | 0.0099 (1.29) | -0.0190 (-1.57) | 0.0289 (1.86)* |
| N | 84 | 84 | 84 |
| R-squared | 0.213 | 0.070 | 0.097 |
| | Panel B: Buy herding | | |
| Intercept | 0.1775 (13.20)*** | 0.0243 (8.55)*** | 0.1532 (12.55)*** |
| Opt | 0.0348 (3.19)*** | 0.0083 (1.98)* | 0.0264 (1.71)* |
| Pess | -0.0351 (0.71)*** | -0.0133 (-3.90)*** | -0.0218 (-1.47) |
| $MR_t$ | 0.0087 (1.14) | 0.0022 (1.72)* | 0.0070 (0.92) |
| $MVol_t$ | 0.0077 (0.75) | -0.0014 (-1.08) | 0.0091 (0.93) |
| N | 84 | 84 | 84 |
| R-squared | 0.161 | 0.293 | 0.113 |
| | Panel C: Sell herding | | |
| Intercept | 0.1558 (15.15)*** | 0.0618 (1.98)** | 0.0940 (3.97)*** |
| Opt | 0.0083 (0.53) | -0.0135 (-0.35) | 0.0217 (1.30) |
| Pess | 0.0219 (-0.72) | -0.0469 (-1.52) | 0.0688 (2.12)** |
| $MR_t$ | -0.0235 (-4.29)*** | -0.0080 (-0.86) | -0.0155 (-1.96)** |
| $MVol_t$ | 0.0022 (0.68) | -0.0176 (-1.41) | 0.0198 (2.25)** |
| N | 84 | 84 | 84 |
| R-squared | 0.208 | 0.045 | 0.163 |

**Table A4**

40/20/40 Sentiment cutoffs and regression analysis for institutional herding.

This table reports the results for the regression analysis for aggregate herding of the quarterly values of beta and the two component parts of beta (‘own-trade herding (institutions following their own trades)’ and ‘true-herding (institutions following the trades of others)’) on the following factors: Sentiment is measured using consumer confidence index. Opt (Pess) is a dummy variable that equals to 1 if the value of the sentiment index in quarter t-1 belongs to the top (bottom) 40% of the times series value and 0 otherwise. $MR_t$ is quarterly stock market returns and $MVol_t$ is quarterly market volatility. Panel A presents results for aggregate herding. Panels B and C present the results for buy and sell herding, respectively. The number of observations and R-squared are reported at the bottom of each panel. The t-statistics are calculated using Newey-West (1987) standard errors. Corresponding t-statistics are reported in parentheses and asterisks refer to different significance levels: *** (1%), ** (5%), * (10%).

| | Regressand: beta | Regressand: Beta-component ‘Own-trade herding’ | Regressand: Beta-component ‘True-herding’ |
|---|---|---|---|
| | Panel A: Aggregate herding | | |
| Intercept | 0.3373 (34.97)*** | 0.0802 (3.61)*** | 0.2571 (10.92)*** |
| Opt | 0.0416 (2.00)** | -0.0187 (-0.86) | 0.0604 (2.02)** |
| Pess | -0.0012 (-0.20) | -0.0494 (-2.31)** | 0.0375 (1.71)** |
| $MR_t$ | -0.0146 (-1.50) | -0.0063 (-0.69) | -0.0083 (-0.64) |
| $MVol_t$ | 0.0117 (1.41) | -0.0202 (-1.66)* | 0.0320 (1.98)** |
| N | 84 | 84 | 84 |
| R-squared | 0.172 | 0.050 | 0.102 |
| | Panel B: Buy herding | | |
| Intercept | 0.1595 (16.01)*** | 0.0209 (8.92)*** | 0.1385 (16.28)*** |
| Opt | 0.0757 (4.11)*** | 0.0161 (3.99)* | 0.0596 (3.39)*** |
| Pess | 0.0204 (1.15) | -0.0051 (-1.74)* | 0.0255 (1.58) |
| $MR_t$ | 0.0079 (0.99) | 0.0021 (1.55) | 0.0058 (0.80) |
| $MVol_t$ | 0.0059 (0.72) | -0.0016 (-1.21) | 0.0075 (0.94) |
| N | 84 | 84 | 84 |
| R-squared | 0.180 | 0.214 | 0.160 |
| | Panel C: Sell herding | | |
| Intercept | 0.1778 (15.15)*** | 0.0592 (2.60)*** | 0.1186 (6.63)*** |
| Opt | -0.0340 (-2.92)*** | -0.0348 (-1.71)* | 0.0217 (0.04) |
| Pess | -0.0323 (-2.46)*** | -0.0443 (-2.05)* | 0.0120 (1.12) |
| $MR_t$ | -0.0225 (-4.02)*** | -0.0084 (-0.91) | -0.0141 (-1.74)* |
| $MVol_t$ | 0.0059 (1.27) | -0.0186 (-1.51) | 0.0244 (2.48)** |
| N | 84 | 84 | 84 |
| R-squared | 0.262 | 0.045 | 0.095 |

**Table A5**

Regression analysis for upgrade stocks.

This table reports the results for the regression analysis for buy herding of the quarterly values of beta and the two component parts of beta ('own-trade herding (institutions following their own trades)' and 'true-herding (institutions following the trades of others)') on the following factors: Opt (Pess) is a dummy variable that equals to 1 if the value of the sentiment index in quarter t-1 belongs to the optimistic (pessimistic) group and 0 otherwise. MRt is quarterly stock market returns and MVolt is quarterly market volatility. Panel A presents results for aggregate herding. Panels B and C present the results for buy and sell herding, respectively. The number of observations and R-squared are reported at the bottom of each panel. The t-statistics are calculated using Newey-West (1987) standard errors. Corresponding t-statistics are reported in parentheses and asterisks refer to different significance levels: *** (1%), ** (5%), * (10%).

| | Regressand: beta | Regressand: Beta-component 'Own-trade herding' | Regressand: Beta-component 'True-herding' |
|---|---|---|---|
| | Panel A: Aggregate herding | | |
| Intercept | 0.3559 (24.03)*** | 0.0971 (2.66)*** | 0.2588 (7.22)*** |
| Opt | 0.0224 (1.03) | -0.0050 (-1.07) | 0.0724 (1.75)* |
| Pess | -0.0198 (-0.88) | -0.0810 (-1.79)* | 0.0612 (1.71)* |
| $MR_t$ | -0.0126 (-1.18) | -0.0065 (-0.67) | -0.0061 (-0.41) |
| $MVol_t$ | 0.0001 (-0.01) | -0.0235 (-1.74)* | 0.0236 (1.56) |
| N | 84 | 84 | 84 |
| R-squared | 0.035 | 0.086 | 0.078 |
| | Panel B: Buy herding | | |
| Intercept | 0.1724 (10.44)*** | 0.0168 (6.30)*** | 0.1556 (10.45)*** |
| Opt | 0.0588 (2.55)** | 0.0131 (3.00)*** | 0.0457 (2.13)** |
| Pess | 0.0007 (0.71) | -0.0083 (-2.59)** | 0.0090 (0.46) |
| $MR_t$ | 0.0107 (1.78)* | 0.0026 (1.71)* | 0.0081 (1.09) |
| $MVol_t$ | 0.0059 (0.64) | -0.0007 (-0.55) | 0.0066 (0.75) |
| N | 84 | 84 | 84 |
| R-squared | 0.142 | 0.274 | 0.119 |
| | Panel C: Sell herding | | |
| Intercept | 0.1835 (10.45)*** | 0.0803 (1.72)* | 0.1032 (3.85)*** |
| Opt | -0.0366 (-1.81)* | -0.0634 (-1.86)* | 0.0268 (0.71) |
| Pess | -0.0206 (-0.88) | -0.0727 (-1.56) | 0.0521 (1.43) |
| $MR_t$ | -0.0233 (-4.30)*** | -0.0091 (-0.94) | -0.0142 (-1.50) |
| $MVol_t$ | -0.0059 (-0.62) | -0.0228 (-1.38) | 0.0170 (1.37) |
| N | 84 | 84 | 84 |
| R-squared | 0.117 | 0.085 | 0.083 |

**Table A6**

Regression analysis for downgrade stocks.

This table reports the results for the regression analysis for buy herding of the quarterly values of beta and the two component parts of beta ('own-trade herding (institutions following their own trades)' and 'true-herding (institutions following the trades of others)') on the following factors: Opt (Pess) is a dummy variable that equals to 1 if the value of the sentiment index in quarter t-1 belongs to the optimistic (pessimistic) group and 0 otherwise. MRt is quarterly stock market returns and MVolt is quarterly market volatility. Panel A presents results for aggregate herding. Panels B and C present the results for buy and sell herding, respectively. The number of observations and R-squared are reported at the bottom of each panel. The t-statistics are calculated using Newey-West (1987) standard errors. Corresponding t-statistics are reported in parentheses and asterisks refer to different significance levels: *** (1%), ** (5%), * (10%).

| | Regressand: beta | Regressand: Beta-component 'Own-trade herding' | Regressand: Beta-component 'True-herding' |
|---|---|---|---|
| Panel A: Aggregate herding | | | |
| Intercept | 0.3482 (20.34)*** | 0.0869 (3.02)*** | 0.2613 (7.24)*** |
| Opt | 0.0348 (1.54) | -0.0413 (-1.41) | 0.0761 (2.34)** |
| Pess | 0.0220 (0.98) | -0.0678 (-2.34)** | 0.0898 (2.32)** |
| $MR_t$ | -0.028 (-1.14) | -0.0038 (-0.50) | -0.0090 (-0.65) |
| $MVol_t$ | 0.0176 (1.54) | -0.0194 (-1.93)* | 0.0370 (2.07)** |
| N | 84 | 84 | 84 |
| R-squared | 0.114 | 0.094 | 0.096 |
| Panel B: Buy herding | | | |
| Intercept | 0.1499 (11.03)*** | 0.0163 (6.54)*** | 0.1336 (12.12)*** |
| Opt | 0.0460 (2.47)** | 0.0076 (2.02)** | 0.0384 (2.25)** |
| Pess | 0.0204 (1.16) | -0.0074 (-2.35)** | 0.0278 (1.74)* |
| $MR_t$ | 0.0133 (1.75)* | 0.0025 (1.93)* | 0.0108 (1.50) |
| $MVol_t$ | 0.0090 (1.02) | -0.0013 (-1.15) | 0.0103 (1.22) |
| N | 84 | 84 | 84 |
| R-squared | 0.084 | 0.038 | 0.098 |
| Panel C: Sell herding | | | |
| Intercept | 0.1984 (14.25)*** | 0.0706 (2.39)** | 0.1278 (4.76)*** |
| Opt | -0.0113 (-0.79) | -0.0490 (-1.63) | 0.0377 (1.32) |
| Pess | 0.0015 (0.09) | -0.0605 (-2.04)** | 0.0620 (2.13)** |
| $MR_t$ | -0.0261 (-3.84)*** | -0.0062 (-0.95) | -0.0199 (-2.25)** |
| $MVol_t$ | 0.0081 (1.54) | -0.0181 (-1.81)* | 0.0262 (2.39)** |
| N | 84 | 84 | 84 |
| R-squared | 0.225 | 0.087 | 0.164 |