Confidence and the welfare of less-informed investors

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Abstract

In response to recommendations by the AICPA Special Committee on Financial Reporting and the Association for Investment Management and Research, the FASB recently invited comment regarding the question, “Given [efficient] markets, would any disservice be done to the interests of individual investors by allowing professional investors access to more extensive information?” [AICPA (1996) Report of the Special Committee on Financial Reporting and the Association for Investment Management and Research, New York, p. 22]. Research in psychology [e.g. Griffin & Tversky (1992) The weighing of evidence and the determinants of confidence. Cognitive Psychology, 411–435] suggests that less-informed investors may suffer from over-confidence and trade too aggressively given their information. This paper reports on an experiment designed to address these issues. In the experiment, security values are determined by the price/book ratios of actual firms, “more-informed” investors observe three value-relevant financial ratios derived from Value-Line reports, and “less-informed” investors observe only one of those signals. Even after market prices have stabilized after many rounds of trading, less-informed investors systematically transfer wealth to more-informed investors as a result of biased prices and overly aggressive trading. However, alerting less-informed investors to the extent of their informational disadvantage eliminates these welfare losses. The results thus suggest that providing information to only professional investors could harm the welfare of less-informed investors if less-informed investors are not aware of the extent of their informational disadvantage.

1. Introduction

Reducing the extent to which some investors are at an informational disadvantage relative to others has been an integral part of the SEC’s mission to ensure fair disclosure (Beaver, 1981b, p. 193; see also Foster, 1986, p. 40; Hand & Beatty, 1992). However, regulators periodically consider regulatory changes that may increase informational inequities. For example, both the FASB and the SEC have experimented with allowing firms to disclose only summary financial information to investors who are unlikely to understand more detailed disclosures (Lee & Morse, 1990). More recently, a report by the AICPA Special Committee on Financial Reporting recommended that “regulators consider whether it would be in the interest of effective capital allocation for certain users... to have access to more extensive information” that other users would not have (AICPA, 1996, p. 22).
These views are partly motivated by academic research in efficient markets theory. If less-informed investors always trade at prices that fully reflect all available information, they are “price-protected,” and will earn the same returns as more-informed investors (Beaver, 1973, 1981a; Foster, 1986; Watts & Zimmerman, 1986). These arguments are reflected in the FASB’s recent invitation to comment, which remarks that allowing the differential disclosure recommended by the AICPA Committee “could be considered in the context of the efficient markets theory. Given such markets, would any disservice be done to the interests of individual investors by allowing professional investors access to more extensive information?” (AICPA, 1996, p. 22).

Recent laboratory and archival research suggests that less-informed investors may not in fact be price protected, because market prices may not always be informationally efficient. Less-informed investors can still protect themselves in such an environment by trading in a way that reflects the adverse selection they face when trading against more-informed investors (Lev, 1988). However, this requires less-informed investors to understand how the statistical reliability of their information compares to that of other investors. Previous psychology studies (e.g. Griffin & Tversky, 1992; Lichtenstein & Fischhoff, 1977; Lichtenstein, Fischhoff & Phillips, 1982; Peterson & Pitz, 1986, 1988) suggest that such accurate assessments may be difficult because less-informed individuals tend to be over-confident in their knowledge and information relative to more-informed individuals.

Relative over-confidence of less-informed investors may lead them to revise their estimates of value too much in response to that information and to be too certain of their biased estimates. As a result, they will tend to buy too aggressively when they have relatively favorable information and sell too aggressively when they have relatively unfavorable information. If relative over-confidence or other factors also cause prices to be too high when less-informed investors hold favorable information and/or too low when they hold unfavorable information, this trading activity would cause less-informed investors to lose wealth by “buying high and selling low.” Providing less-informed investors with explicit information (“guidance”) about the relative reliability (i.e. explanatory power) of their information might reduce their relative over-confidence, and thus, reduce these wealth losses. This paper reports an experiment that investigates these issues.

In the experiment, two more-informed investors observe three informative signals, while two less-informed investors observe only one of those signals. In addition to the amount of information available to particular investors, we manipulate whether or not investors receive guidance as to the reliability of their information. Our guidance communicates only the amount of variance explained by the information held by each class of investor (i.e. no information useful in determining the value of the security is conveyed). Trading takes place in a computerized specialist market (Bloomfield & Libby, 1996).

After many rounds of trading, prices in these markets converge to a “steady-state price” at which supply approximately equals demand. We find that average investors’ estimates of value are too high (low) and the securities are over-priced (under-priced) when relatively favorable (unfavorable) information is held by less-informed investors. Furthermore, in the absence of guidance about signal reliability, the less-informed investors’ estimates of value are higher (lower) than those of the more-informed investors for these over-priced (under-priced) securities. As a consequence, less-informed investors show a strong tendency to buy from (sell to) more-informed investors at steady-state prices when securities are over-priced (under-priced) in this condition. Thus, less-informed investors effectively “buy high and sell low,” systematically transferring wealth to more-informed investors when guidance is absent.4

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3 See, e.g. archival studies by Bernard and Thomas (1989, 1990), Hand (1990), Frankel and Lee (1998), Sloan (1996), and Lee, Myers, and Swaminathan (in press), and experimental studies by Bloomfield (1996b), Bloomfield and Libby (1996), and Calegari and Fargher (1997).

4 Although such welfare losses would not be surprising in early rounds of trading (e.g. see Plott & Sunder, 1982, 1988; Forsythe & Lundholm, 1990), in an efficient market no such losses would occur once the market reaches a steady-state (equilibrium) price.
As predicted, we also find that providing less-informed investors with guidance on signal reliability reduces (and in fact eliminates) their welfare losses at steady-state prices, by causing their estimates of values and trading behavior at steady state prices to become indistinguishable from those of more-informed investors. Interestingly, however, we also find that guidance does not sufficiently reduce the over-confidence of the less-informed investors in early rounds to eliminate the overall biases in steady-state market prices — even in the presence of guidance, steady state prices are too high (low) when less-informed investors hold favorable (unfavorable) information. This suggests that the biases in steady-state prices are due to general difficulties of aggregating public and private information in financial markets, similar to those discussed in Bloomfield (1996a) and Bloomfield and Libby (1996), which may be compounded when the over-confident less-informed investors trade aggressively in early rounds.

To clarify the role of confidence in the above results, a second group of subjects performed a supplementary pencil and paper task to directly compare the more- and less-informed investors' confidence and the impact of guidance on confidence. In the absence of guidance, the less-informed investors' confidence was indistinguishable from the more-informed, indicating that the less-informed were relatively over-confident. Guidance significantly decreased the confidence of the less-informed.

These results, combined with those of the experiment, are consistent with our proposed linkages between amount of information, guidance, confidence, and trading behavior. Welfare losses by less-informed investors at steady-state prices are caused not by the fact that less-informed investors are at an informational disadvantage (which they always are in our markets), but rather by the tendency of less-informed investors to underestimate the extent of that disadvantage (i.e. to be relatively over-confident). This result suggests that less-informed investors might be helped by disclosures which act in a manner similar to our guidance manipulation, simply making less-informed investors more aware of their informational disadvantage. For example, even if less-informed investors' lack the training or resources to interpret footnotes, disclosing those footnotes might improve their welfare by highlighting the extent of their information disadvantage relative to investors who have greater training and resources. Conversely, proposals to provide only summary financial statements to less-informed investors, and to better inform some investors without disclosure to other investors, might harm less-informed investors by concealing the extent of their informational disadvantage.

The remainder of the paper is organized as follows. Section 2 provides background and hypotheses. Sections 3 and 4 describe the method and results. Section 5 discusses the implications of the results and directions for further study.

2. Theory and hypotheses

2.1. Over-confidence

Previous research in psychology suggests that errors in assessing the reliability of information are likely to take a consistent form: people with little information will tend to be too confident, relative to those with more information (Lichtenstein & Fischhoff 1977; Lichtenstein et al., 1982). Two related sets of studies suggest a cause for these findings. First, Griffin and Tversky (1992, Study 1) provide evidence in a variety of contexts that individuals rely on the balance of data for or against a hypothesis, with insufficient regard for the reliability of the data. They suggest that this leads less-informed individuals to be over-confident, particularly when relatively unreliable data takes on extreme values. Second, Peterson and Pitz (1986, 1988) provide evidence that possessing a greater number of independent information signals increases the chance that the signals conflict, and this conflict decreases both the extremity of predictions and confidence. Thus, while more information may increase confidence, conflict among items of information can decrease confidence. They also show less-informed individuals to be particularly insensitive to the reliability of their data when that reliability does not vary much from one decision to another. This circumstance is
likely to reflect actual investment settings. For example, most individual investors probably receive some information of low reliability for all of the securities they trade.

2.2. Welfare effects

If the steady-state price is perfectly informationally efficient (i.e. it fully reflects all information available to the market in the aggregate), less-informed investors are “price-protected” and will not lose any money as a result of their trading strategy. However, previous laboratory research indicates that prices tend to respond more strongly to information that is held by more investors (Bloomfield, 1996a, 1996b; Bloomfield & Libby, 1996; Forsythe & Lundholm, 1990; Lundholm, 1991; Plott & Sunder 1982, 1988). The information that is held by more investors is likely to be the information that less-informed investors possess (i.e. more-informed investors know what less-informed investors know, and more). Consequently, prices will tend to be higher when less-informed investors hold a favorable item of information than when less-informed investors hold an unfavorable item of information, even though more-informed investors know both items (so that the information available to the market remains constant).^{5}

The psychology studies discussed above suggest that less-informed investors will be relatively more over-confident than will more-informed investors. This relative over-confidence will cause their estimates of value to be higher (lower) than those of the more-informed investors when they hold relatively favorable (unfavorable) information. They will also be too certain that their biased estimates are accurate. As a consequence of these differences in estimates of value and their undue certainty, less-informed investors will show a tendency to buy from (sell to) more-informed investors at steady-state prices when they hold relatively favorable (unfavorable) information.^{6} If, as suggested above, securities are overpriced (under-priced) when the less-informed investors hold relatively favorable (unfavorable) information, employing this trading strategy will cause the less-informed to transfer wealth to more-informed investors as a result of “buying high and selling low.”

Our first hypothesis examines whether, in the absence of guidance, less-informed investors transfer wealth to more-informed investors at steady state prices.

H1: Less-informed investors transfer wealth to more-informed investors at steady-state prices in the absence of guidance on signal reliability.

We examine wealth transfers by constructing markets in which two more-informed investors hold all three value-relevant signals and two less-informed investors hold only one of those signals. For each security traded, different groups of investors trade the same security in settings that are identical except for which of the three signals the less-informed investors hold. Because the information available to the more-informed investors is the same (and therefore the total information available to the market is the same), the informationally efficient price is the same in both settings. However, the favorability of the signal held by the less-informed investors differs depending on which signal the less-informed investor holds. While the informationally efficient price is the same in both settings, as we note above, we expect prices to be biased in the direction of the signal held by the less-informed investors. We also expect the less-informed investors’ estimates of value and trading to be more biased than that of the more-informed. As a consequence, they will transfer wealth to the more-informed by buying over-priced and selling under-priced securities to the more-informed.

Presumably, wealth transfers could be arising at every point throughout the trading process. We

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^{5} Stronger reactions to public information than to private information do not preclude under-reactions to public information. A market could under-react to all information available, but under-react less to public information.

^{6} If less-informed and more-informed investors were equally over-confident, both would trade more aggressively than they would otherwise and the effects of over-confidence would offset.
focus only on wealth transfers that occur after many rounds of trading have led the market to a “steady-state” price at which supply equals demand, because these prices should represent the most informationally efficient prices, and therefore should price-protect less-informed investors to the greatest extent. Also, previous research has already established that uninformed investors earn less than better-informed investors before information is impounded in market prices as completely as it can be (Forsythe & Lundholm, 1990; Plott & Sunder, 1982). If less-informed investors are unable to protect themselves from welfare losses at prices that are as informationally efficient as possible in our market setting, it seems unlikely that they would avoid losses before that point.

The studies cited above have found no significant welfare differences between informed and uninformed investors once prices reach steady-state levels. For example, Plott and Sunder (1982) find that closing prices are so informationally efficient that all traders earn approximately the same amount from trade. Experienced subjects in Forsythe and Lundholm (1990) reveal a similar result. However, the simplicity of the information environments in these studies make it difficult for psychological biases such as over-confidence to affect prices and welfare. For example, in many of these experiments less-informed investors are entirely uninformed, which would discourage any attempts by them to trade on their own information. Also, more-informed investors in those markets receive information that is so informative and objective that there is little room for them to exercise their judgement in interpreting it. [For example, subjects in most of the markets in Plott & Sunder, Forsythe & Lundholm, and Lundholm (1991) learn the true value with certainty, learn that the security has one of two values with certainty, or receive no information at all about security value.] One of the goals of this paper is to explore psychological biases that arise when investors must exercise judgement in interpreting their information.

2.3. Guidance

Understanding the psychological cause of poor decision performance facilitates identification of a decision aid that is designed to improve performance (Bonner, Libby & Nelson, 1996). If overly-aggressive trading behavior by less-informed investors is in fact driven by the relative over-confidence of less-informed investors, then helping these investors assess the reliability of information should diminish their welfare losses. Two findings in the psychology literature suggest a simple and effective form of guidance that should reduce the confidence of less-informed investors. First, a large number of studies have examined the effectiveness of different forms of feedback in multiple cue probability learning tasks. This literature is aimed at determining what feedback conditions promote or deter learning in tasks similar to our trading settings, where participants predict uncertain outcomes based on cues with different reliabilities [see Libby (1981, Chapter 2) for a description of typical studies and results]. Many of these studies compare the effectiveness of “outcome” feedback (where subjects are given the true value after each case) with “task-properties” feedback (where the relative reliabilities of the cues are provided). In general, learning and performance are far superior in the task-properties-feedback condition. Second, while the probability judgment literature has generally found over-confidence to be difficult to debias, a recent study by Trafimow and Sniezek (1994) found that providing subjects with information about their general knowledge level (a simple form of task properties feedback) reduces subjects’ confidence, and thus subjects’ over-confidence. These findings suggest that providing less-informed investors with guidance about the relative reliability of their information may reduce the relative over-confidence of these investors compared to that of more-informed investors. This, in turn, should reduce the bias in their value estimates and the aggressiveness of less-informed investors’ trading decisions, and reduce their wealth transfers to the more-informed investors.

If the trading bias predicted by H1 is in fact driven by the relative over-confidence of less-informed investors, then providing guidance

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7 See Bonner and Walker (1994) for similar findings that show the advantage of explanatory feedback over outcome feedback.
concerning the reliability of their information should diminish less-informed investors’ welfare losses. To address this issue, we manipulate whether or not less-informed investors are given information about the reliability of the signals that are available to the market. If trading bias is driven by the relative over-confidence of less-informed investors, then guidance should make those investors less confident, and reduce this bias.

$H2$: Providing less-informed investors with guidance on signal reliability reduces wealth transfers from less-informed investors to more-informed investors at steady-state prices.

We also manipulate whether or not more-informed investors are given guidance on signal reliability. However, we make no hypothesis about the effect of guidance on more-informed investors, because that effect depends on whether or not more-informed investors who lack guidance are over-confident. If more-informed investors tend to be over-confident in the absence of guidance, then providing guidance to more-informed investors will decrease their over-confidence. This in turn may increase wealth transfers by increasing the over-confidence of less-informed investors relative to the confidence of more-informed investors. On the other hand, if more-informed investors tend to be underconfident in the absence of guidance, providing guidance to more-informed investors may increase their confidence and decrease wealth transfers by decreasing the over-confidence of less-informed investors relative to the confidence of more-informed investors. Finally, more-informed investors who lack guidance may accurately assess the reliability of the information they hold, yielding no guidance effects. We cannot discriminate between these predictions, so we state no hypotheses about the effect of providing guidance to more-informed investors.

3. Method

3.1. Subjects

All subjects (“investors”) were MBA students at Cornell’s Johnson Graduate School of Management who had participated in at least one prior experimental market.

3.2. Security values and information

In our markets, investors make judgments about securities whose values are derived from values of real-world securities, given financial information derived from “Value-Line” analyses of those securities. Specifically, security values are determined by each firm’s price/book ratio, and investors are given information on the firm’s return-on-equity, growth in return-on-equity (as projected by Value-Line), and book value per share.

We attempt to present investors with a valuation task similar to that facing investors in real-world exchanges, while still ensuring that the informative signals presented to investors are easy to understand, can explain an economically significant portion of variation in security values, and possess a minimal amount of colinearity and interdependence. We achieve these goals by deriving security values from price/book ratios and deriving signals from common accounting ratios. In this way, we are able to use extant theory and empirical work (Bernard, 1994; Frankel & Lee, 1998) to develop a small number of signals that explain a majority of variation in price/book ratios.8

To obtain our securities and signals, we first construct a database which includes all 291

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8 Using information derived from real-world sources (as opposed to more objective information such as random numbers) allows investors to determine the meaning and statistical reliability of their signals by relying on their own knowledge and experience. These are the circumstances in which over-confidence tends to be observed. A real-world valuation task should also increase the motivation of our subjects, and allow the study to provide some educational benefit to the subjects, who are MBA students. These advantages are diminished to the extent that the subjects are unfamiliar with the nature of price/book ratios, and to the extent that the signals we use differ from the naturally occurring signals reported in Value-Line. However, we have designed our experiment so that these possibilities cannot account for welfare losses by the less-informed investors. In particular, welfare losses require the less-informed investors to be more over-confident than the more-informed. While unfamiliarity with the information signals could cause all subjects to be over- or under-confident, it is not clear how it could cause a greater difference in the confidence levels of the two groups.
manufacturing firms which were profitable in 1993 and covered by Value-Line reports. We rank these firms according to their price/book ratios (the most recent market price available prior to publication of the Value-Line report divided by the net book value per share). The percentile rank of each firm (denoted PRICE/BOOK) is then used as the value of the associated security. For example, a firm with a price/book ratio greater than 24% of all firms in the database is given a value of 24 francs (a fictitious currency ultimately converted to cash). The first signal providing information about PRICE/BOOK is an ROE score which reflects the firm’s relative return-on-equity (net income before extraordinary items divided by net book value) relative to other firms in the population. The second signal is a GROWTH score, which reflects the rate at which Value-Line projected return-on-equity for the firm to grow from 1992 to 1994. The third signal is a BOOK score, which reflects the relative book value for each share of the firm’s stock. We also use a simple orthogonalization technique to ensure that the signals are largely independent, and present all scores on an 11-point scale. This orthogonalization should increase the effectiveness of our manipulation, because it insures that less-informed investors are significantly less informed than more-informed investors.\footnote{If the single signals possessed by less-informed investors were highly correlated with the three signals held by more-informed investors, there would be little difference in the amount of explanatory power of the information held by less- and more-informed investors, and consequently a weak treatment effect.} Appendix A contains instructions to subjects which describe the construction of the securities, including the orthogonalization technique, in detail.

Panel A of Table 1 provides the results of a linear regression of PRICE/BOOK onto ROE, BOOK and GROWTH. Consistent with empirical research, all three of the signals are positively and statistically significantly related to PRICE/BOOK. Overall, the three signals explain 60.7% of the variation in security value. Panel B of Table 1 shows the ten securities used in the experiment. The securities were selected randomly and have values throughout the 100-franc scale and signals with realizations throughout their 11-point scales.

3.3. Trading

Subjects trade in computerized specialist markets similar to those used by Bloomfield (1996b) and Bloomfield and Libby (1996). These markets are based on the New York Stock Exchange, in which a specialist quotes prices at which investors can trade, the specialist fills all orders investors tender at those prices, and the specialist changes those prices in response to investors’ previous trades. In our laboratory markets, each group of four investors (which we call a cohort) always trades together. Each of the 10 securities (a claim on a terminal dividend) they trade is denominated in “francs.” Trading is a batch process — all four investors in a cohort enter their buy or sell orders before any investor chooses their next action. Trading round refers to each time all investors in the cohort enter buy and sell orders for shares of a security. Each security is traded for 15 rounds before trading begins in the next security. We refer to the sequence of 15 rounds of trading for a single security as a market.

Before learning the market price for each round of trading, investors enter their best estimates of the security’s value. These estimates allow us to test whether trading losses are driven by biased estimates of value. Investors then enter orders to buy (sell) from 0 to 10 shares if their estimate is above (below) the market price, but cannot trade if their estimate is exactly equal to the market price. After each round, investors learn the aggregate numbers of buy and sell orders at the previous price. The specialist fills all orders.

Our specialist market allows shortselling, so the number of shares bought and sold at a given price is not influenced by either wealth constraints or how shares are distributed among investors. Ganguly, Kagel and Moser (1994) show how short-selling limitations can allow biases to persist, because investors who wish to exploit high prices cannot do so unless they own shares. The lack of shortselling restrictions (beyond the maximum 10 share trade/round) allows investors in our markets to exploit price errors in any direction, regardless
of their holdings, so prices in our markets provide a less noisy reflection of investors’ value estimates and their confidence in those estimates.\textsuperscript{10}

Trading for a security always begins at 50 francs. To set the price for the next round, the computer revises the price upward (downward) if there are more (fewer) buy orders than sell orders, with the magnitude of movement an increasing function of the imbalance.\textsuperscript{11} Under this price revision rule, prices should not settle at a level which differs substantially from investors’ estimates of value — if the price is too high (low), investors will drive it downward (upward) until they can achieve no further gains. Eventually, the market settles into a narrow range of prices at which average supply roughly equals average demand. We call the average of these prices the “steady-state” price. Trading continues for 15 rounds, which we expected would be long enough to allow several rounds of trading after the steady-state price is reached.

3.4. Instructions

The first 20 minutes of each experimental session are spent reviewing two sets of instructions. The first set of instructions explains the computation of gains and losses from buying and selling, the computation of gains from accurate estimates of security value, the trading process, the mechanism by which prices are adjusted after each round of trading, and the conversion of winnings from

\begin{table}
\centering
\caption{Relate of signals to security value.\textsuperscript{a}}
\begin{tabular}{lllll}
\hline
\multicolumn{5}{c}{Panel A:\textsuperscript{b}; estimation of regression model} \\
\hline
$\alpha$ & $\beta_{\text{ROE}}$ & $\beta_{\text{GROWTH}}$ & $\beta_{\text{BOOK}}$ & $R^2$ \\
\hline
\text{-0.06} & 0.058 & 0.020 & 0.035 & 60.7\% \\
\text{(\text{-2.06})} & (17.21) & (5.75) & (9.99) & \\
\text{p=0.04} & $p<0.001$ & $p<0.001$ & $p<0.001$ & \\
\hline
\multicolumn{5}{c}{Panel B:\textsuperscript{c}; securities used in experiment} \\
\hline
\text{Security number} & \text{ROE} & \text{BOOK} & \text{GROWTH} & \text{TRUE VALUE} \\
\hline
\text{1d} & 6 & 7 & 7 & 67 \\
\text{2} & 10 & 10 & 97 \\
\text{3} & 9 & 9 & 74 \\
\text{4} & 1 & 7 & 4 & 71 \\
\text{5} & 1 & 5 & 36 \\
\text{6d} & 4 & 9 & 10 & 94 \\
\text{7} & 4 & 8 & 1 & 14 \\
\text{8} & 3 & 2 & 5 & 30 \\
\text{9d} & 0 & 5 & 7 & 16 \\
\text{10} & 4 & 0 & 8 & 47 \\
\hline
\end{tabular}
\begin{flushleft}
\textsuperscript{a} VALUE is defined as the percentile rank of the firm’s price/book ratio in the sample of 291 profitable manufacturing firms covered by Value-Line reports. ROE is a number between 0 and 10 representing the relative rank of the firm’s return-on-equity in the sample. GROWTH is a number between 0 and 10 representing the rank of Value-Line’s projection of the firm’s percentage ROE growth relative to other firms in the same ROE category. BOOK is a number between 0 and 10 representing the rank of the firm’s book value per share relative to other firms in the same ROE category. For ROE (GROWTH), a higher score indicates a higher relative ROE (growth projection). For BOOK, a higher score indicates a lower relative book value per share.

\textsuperscript{b} Panel A reports the results of an OLS estimation of the regression model

$$\text{VALUE} = \alpha + \beta_{\text{ROE}} \text{ROE} + \beta_{\text{GROWTH}} \text{GROWTH} + \beta_{\text{BOOK}} \text{BOOK} + \varepsilon.$$ 

\textsuperscript{c} Panel B lists the ten securities used in the experiment.

\textsuperscript{d} These securities were not included in the primary analysis because of the small difference between the values of BOOK and GROWTH.

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\end{table}

\textsuperscript{10} Other advantages of the specialist market are its ability to provide an unambiguous closing market price and a simple trading environment. See Bloomfield (1996b) and Bloomfield and Libby (1996) for further discussion of the strengths and limitations of this market mechanism.

\textsuperscript{11} The details of the price algorithm are available from the authors upon request.
francs to dollars. These instructions also emphasize that no deception will be employed by the experimenters at any time (see Appendix C). The second set of instructions explains how we calculate PRICE/BOOK, ROE, GROWTH and BOOK, and provides brief rationales for the sign of the relation between each signal and PRICE/BOOK (see Appendix A).

The second set of instructions also informs all members of each cohort of the distribution of information within the cohort (i.e. subjects in a cohort where less-informed investors received GROWTH [BOOK] are informed that: “Two of the investors in the market know ROE, GROWTH and BOOK. The other two investors know only GROWTH [BOOK]”). If a cohort is designated as having guidance provided to less-informed investors and/or to more-informed investors, the guidance is distributed at the end of the instructions (see Appendix B). Subjects not receiving guidance in a given cohort are told if the other subjects in the cohort receive guidance (i.e. that other subjects have received information concerning the reliability of the three signals).

The next 25 minutes of the experimental session are spent trading two practice securities without financial incentives for five rounds each. At this time one of the experimenters answers questions while subjects trade. After completing trading in the practice securities, subjects trade ten securities with incentives.

3.5. Incentives

Subjects gain or lose francs by trading shares of each security. Gain or loss from trading in each round is calculated by multiplying the number of shares a subject purchased by the difference between true security value and current market price. Subjects who purchase (sell) securities earn francs if value is greater (less) than price, and lose francs if value is less (greater) than price. Subjects also earn francs by estimating the value of the security accurately in the first and last round of trading. This bonus should encourage subjects to provide reliable initial and final value estimates. A perfectly accurate estimate results in a bonus of 300 francs; this bonus is reduced by 10 francs for every franc that the estimate deviates from true value, to a minimum of 0 francs for estimates 30 francs or further from true value. Gains from trading and estimates are not revealed until trading in a security is complete, so as not to reveal its true value. For each subject, francs are converted to dollars by distributing $40 pro rata (on the basis of francs earned) between that subject and another subject who holds identical information but trades in a different cohort in the same cell of the design.12 This conversion method guarantees that subjects with different information have the same expected payoffs and incentives. Imposing this equality by using different conversion rates for more- and less-informed investors would confound information with incentives, making it difficult to interpret the results of the study.13

3.6. Experimental design

Our experiment uses 16 cohorts of four investors each.14 All 16 cohorts trade the same ten securities

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12 For example, the number of francs earned by a less-informed investor holding only the GROWTH signal in a cohort where both less- and more-informed investors receive guidance is compared to the number of francs earned by another less-informed investor holding only the GROWTH signal and trading in another cohort where both less- and more-informed investors receive guidance. Letting \( V \) and \( W \) denote the winnings of the two subjects, subject 1 receives \( \frac{40 \times (W)}{(W + V)} \), and subject 2 receives the remainder of the $40. If one of the two subjects earned negative francs, that subject was awarded $5 for participating, and the other subject received the entire $40.

13 Although our conversion method superficially resembles a “tournament scheme”, it has none of its characteristics. Tournament schemes can induce subjects to prefer losing francs, if doing so will cause other subjects to lose more. Because we compare subjects only to subjects in other cohorts, subjects cannot affect their wealth by increasing or decreasing the winnings of other investors in their own cohort (after controlling for their own winnings). Tournament schemes can also induce risk-seeking behavior because the only way to increase earnings is to win the tournament (e.g. by having the most francs at the end of trading). Our subjects increase their dollar earnings with each franc they earn.

14 Using four investors is consistent with prior research in specialist markets (Bloomfield & Libby, 1996; Bloomfield, 1996b). Adding more traders to a market is expensive, but does not increase the statistical power of the experiment, because each cohort is treated as a single independent observation. Previous experiments have shown that even small markets of three or four investors behave as competitively as larger markets (Friedman & Ostroy, 1995).
in the same random order. In every cohort, two more-informed investors hold all three signals, while two less-informed investors hold only one of the three signals. In all cases, the information presented to the market as a whole is held constant. In half of the cohorts, the less-informed investors receive BOOK, and in the other half of the cohorts, the less-informed investors receive GROWTH. To allow us to truthfully inform subjects that they are trading a random sample of securities drawn from the population of securities in our data base, our sample firms include securities where BOOK and GROWTH are equal or nearly equal. Little treatment effect would be anticipated when the difference between BOOK and GROWTH is small. Therefore, we focus our primary analyses on the seven securities for which BOOK and GROWTH differ substantially, and delete securities 1, 6 and 9 (where the difference between BOOK and GROWTH are 0, 1, and 2, respectively).

3.6.1. Guidance

We manipulate whether less- and more-informed investors are provided guidance in a 2×2 between cohorts design. Investors provided guidance receive the information shown in Appendix B.

3.6.2. Dependent measures

Following the logic of the hypothesis development, we first examine whether steady state prices are biased in the direction of the information held by the less-informed investors. We then test whether the less-informed investors’ estimates of value and trading strategies are more biased in that direction than those of the more-informed investors. Finally, we test for the predicted transfers of wealth and guidance effects. We define:

\[
\text{PRICE ERROR} = \text{PRICE} - \text{VALUE};
\]

\[
\text{ESTIMATE ERROR} = \text{VALUE ESTIMATE} - \text{VALUE};
\]

and

\[
\text{NET PURCHASES} = \text{PURCHASES} - \text{SALES}.
\]

Since all cohorts trade all securities, and in half of the cohorts the less-informed investors receive BOOK and in the other half GROWTH, each cohort trades some securities where the less-informed investors receive the more-favorable signal of the two, and some securities where the less-informed investors receive the less-favorable signal. Specifically, the less-informed investors who receive BOOK have the less-favorable signal for securities 2, 3, 8, and 10 and the more-favorable signal for 4, 5, and 7. Less-informed subjects that receive GROWTH have the opposite pattern. Since we expect the less-informed to buy when they receive the more-favorable signal and sell when they receive the less-favorable signal, we expect PRICE ERROR, ESTIMATE ERROR, and NET PURCHASES to have the same sign as the signal received by the less-informed investors (“+” for more-favorable and “−” for less-favorable). Thus, we can define our dependent variables:

\[
\text{PRICE BIAS} = a \times \text{PRICE ERROR};
\]

\[
\text{ESTIMATE BIAS} = a \times \text{ESTIMATE ERROR};
\]

\[
\text{TRADING BIAS} = a \times \text{NET PURCHASES};
\]

and

\[
\text{TRADING PROFIT} = (\text{NET PURCHASES}) \times (\text{VALUE} - \text{PRICE PAID});
\]

15 This “nesting” of the less-informed investors’ information within the more-informed investors’ information reflects our belief that more-informed investors in real markets typically hold all of the information held by less-informed investors, and more.

16 To assess the sensitivity of results to the deletion of securities, we subsequently conducted our primary tests based on (1) the nine securities that remain after we delete the security (Security 1) where |BOOK-GROWTH| = 0 (this security has to be deleted, since BOOK cannot be identified as more- or less-favorable than GROWTH when BOOK = GROWTH), and (2) the five securities that remain after we delete those securities (Securities 1, 4, 6, 8, and 9) where |BOOK-GROWTH| < 4. Results are similar across the various deletion rules.

17 Expected values of securities were calculated using the regression equation shown in Panel A of Table 1. Results of hypothesis tests are robust to error in expected values, as security (and expected value) is held constant in comparisons between the information and guidance treatments.
where \( a = +1 \) when the less-informed investors receive the MORE-favorable signal of the two and \( a = -1 \) when the less-informed investors receive the LESS-favorable signal.

To test our hypotheses, we average the values of the dependent variables across the seven securities used in our analyses, and compare them between our information and guidance treatments. If market prices respond more strongly to information that is held by all investors, then PRICE BIAS will be positive. Similarly, in our no-guidance setting, less-informed investors’ ESTIMATE BIAS and TRADING BIAS should be greater than more-informed and their TRADING PROFITS should be less than those of the more-informed. These differences must be driven by differences in the distribution of information among investors, because the information available to all investors in the aggregate is held constant.

4. Results

In all of the analyses, providing guidance to the more-informed investors had no significant effect nor did it interact significantly with any other variable. As a consequence, all of the analyses presented collapse cells over the two levels of this variable. In all of the graphs and statistical analyses presented, we compute average values of the dependent variables across the seven securities. In the statistical tests, we define the period of steady-state prices as the last four rounds of trading and we average values of the dependent variables over these last four (steady-state) rounds of trading. Following the logic of the hypothesis development, we first test whether PRICE BIAS is significant and whether it is affected by guidance. We then test whether ESTIMATE BIAS, TRADING BIAS, and TRADING PROFIT (averaged across the seven securities) differ between the more- and less-informed investors and by guidance condition as predicted. Our statistical tests related to H1 involve comparing mean values of the measures between the more- and less-informed investors across the eight cohorts in the no-guidance condition using simple paired \( t \)-tests. Our tests related to H2 involve comparisons of the eight cohorts in the guidance condition to the eight in the no-guidance condition.

4.1. Price bias

Since bias in prices is a necessary condition for wealth transfers at steady-state prices, before testing H1, we examine whether steady-state market prices are higher (lower) when favorable (unfavorable) information is held by less-informed investors. Fig. 1 presents a graph of the mean PRICE BIAS across the seven securities in the no-guidance and guidance settings for each trading round. In round one, there is no price bias since starting price is always set at 50. The figure indicates that PRICE BIAS is reduced in the first three rounds of trading and then stabilizes. Mean PRICE BIAS at steady state was 4.02 and 3.83 francs across the eight cohorts in the no-guidance and guidance conditions, respectively. Both means were significantly greater than zero (no-guidance setting, \( t = 3.65, p = 0.004 \) and guidance setting \( t = 2.63, p = 0.017 \), one-tailed), indicating that prices in both conditions are biased in the direction of the information held by the less-informed investors.

It is possible that the price biases arise because the markets do not in fact achieve a steady-state price at which supply and demand are equal. To address this possibility, we examine trading
imbalances in the last four rounds of trading in each market. For the last four rounds of trading in each security, we identify the lowest price at which more shares are sold than bought (LOWSELL), and the highest price at which more shares are bought than sold (HIGHBUY). The average difference (LOWSELL − HIGHBUY) is only 1.3 francs. The median difference is 1 franc, while the maximum difference is only 5 francs.

We also note that the securities average 1.9 price reversals in the last four rounds of trading (compared to a maximum possible of 3), with over half exhibiting two or more reversals. The narrow range between LOWSELL and HIGHBUY and frequent price reversals within that range indicates that steady-state prices are not much different from the prices that would make supply and demand exactly equal.

20 These computations exclude one of the 112 market prices (7 securities × 16 cohorts), because more shares are bought than sold in each of the last four trading rounds. Because the price moves in the same direction in each of the last four trading rounds, we can infer only that the true steady-state price for that security may be any point above HIGHBUY. Our inferences are unchanged when this security is deleted in the analysis.

4.2. Welfare effects

H1 asserts that, in the absence of guidance, less-informed investors’ relative over-confidence will lead them to transfer wealth to more-informed investors by buying at high steady-state prices when they hold the more-favorable signal and selling at low steady-state prices when they hold the less-favorable signal. Specifically, our hypothesis development suggests that, as a result of their relative over-confidence, less-informed investors’ ESTIMATE BIAS will be greater than that of the more-informed, indicating that their estimates of value are more biased in the direction of the signal held by the less-informed. Panel A of Fig. 2 also indicates that the less-informed investors’ estimates
Fig. 2. Estimate bias and price bias in each round.
are consistently more biased than prices, while the more-informed investors’ estimates are less biased. This suggests that the less-informed should buy from (sell to) the more-informed when they receive the more- (less-) favorable signal. Panel A of Fig. 3 presents TRADING BIAS for each round in the no-guidance setting for the more- and less-informed investors. This graph indicates that, consistent with the differences in ESTIMATE BIAS, in all rounds, the less-informed investors are buying when they received the more-favorable signal and/or are selling when they have receive the less-favorable signal. Since prices are also biased in the direction of the signal received by the less-informed investors, the pattern of trading indicated in Fig. 3 should result in the wealth transfers predicted by H1. Panel A of Fig. 4 presents TRADING PROFITS for each round in the no-guidance setting for the more- and less-informed investors. Consistent with the TRADING BIAS results, the more-informed earn higher TRADING PROFITS in each round.

Panel A of Table 2 presents statistical comparisons at steady-state prices. Consistent with our hypothesis development, less-informed investors’ ESTIMATE BIAS and resulting TRADING BIAS are significantly greater than that of the more informed (\(p = 0.000\) and \(p = 0.000\), respectively). Consistent with H1, TRADING PROFIT of the more-informed investors (39.37 francs) is significantly greater (\(p = 0.004\)) than that of the less-informed investors (\(-9.95\) francs).

Our result differs from Plott and Sunder (1982), who find that there is no significant advantage to being more-informed once prices achieve a steady state. We believe that this difference arises primarily because of the greater difficulty of the task we present to our subjects, which we believe more closely approximates the complexity of the information available in many real-world markets. In Plott and Sunder (1982) there are only two possible outcomes for each security, more-informed investors can know that value exactly, and investors with similar information are likely to agree on its implications for security value. In our study, there are 100 possible outcomes for each security, more-informed investors still face significant uncertainty regarding security value, and investors with similar information may disagree on its implications for security value. As in Forsythe and Lundholm (1990) and Lundholm (1991), a greater degree of complexity probably accounts for the failure of our markets to reach the exceptionally high efficiency levels observed in Plott and Sunder.

4.3. Effects of guidance

H2 asserts that providing less-informed investors with guidance concerning signal reliability will reduce their relative over-confidence and reduce the transfers of wealth from the less-informed to the more-informed investors at steady-state prices. Our hypothesis development suggests that if the less-informed investors’ over-confidence is reduced, ESTIMATE BIAS and TRADING BIAS will also be reduced, which should result in a reduction of the differences in TRADING PROFITS.

As noted earlier, PRICE BIAS is necessary for wealth transfers at steady-state prices. PRICE BIAS remains significant (\(p = 0.017\)) and is only reduced by 0.19 francs (\(p = 0.46\)) by the presence of guidance. In the presence of continued bias in prices, differences in ESTIMATE BIAS should result in differences in TRADING BIAS and TRADING PROFITS. Panel B of Figs. 2–4 present the results for these three variables for the eight cohorts in the guidance setting. Fig. 2 indicates that, although biased estimates by the less-informed investors in early rounds were sufficient to produce biased steady-state prices, by the last four rounds, the ESTIMATE BIAS of the less- and more-informed converged. Since there was no remaining difference in ESTIMATE BIAS there should be no motivation to trade at steady-state prices. Consistent with this, Fig. 3 reveals that TRADING BIAS was eliminated. As a consequence, Fig. 4 indicates that differences in TRADING PROFITS at steady-state prices were also eliminated.\(^{21}\)

\(^{21}\) The elimination of profit differences in steady-state rounds does not imply that there is no advantage to being more-informed. As in other studies with differentially informed investors (such as Plott & Sunder, 1982), Fig. 4 shows that the more-informed investors earn substantially more than the less-informed in the first few rounds of trading, which is before the steady-state price is achieved.
Fig. 3. Trading bias by round.
Fig. 4. Trading profit by round.
Panel B of Table 2 presents statistical tests of these differences in the ESTIMATE BIAS, TRADING BIAS, and TRADING PROFITS between the less- and more-informed investors at steady-state prices for the eight cohorts in the guidance setting. Consistent with the figures discussed above, none of these differences are significant. Panel C of Table 2 compares the difference in steady-state ESTIMATE BIAS, TRADING BIAS, and TRADING PROFITS between the less- and more-informed investors across the two settings. These tests indicate that, consistent with the development of H2, guidance reduced the differences in ESTIMATE BIAS \( (p = 0.057) \) and TRADING BIAS \( (p = 0.002) \) between the less- and more-informed. Differences in TRADING PROFITS were also significantly reduced \( (p = 0.032) \), supporting H2.

By comparing less-informed investors’ profits across the guidance and no-guidance conditions, we can assess the economic importance of the bias observed in the no-guidance condition. Comparing Panels A and B of Fig. 4 shows that guidance increases the profits of the less-informed by about 25 francs over the last 10 rounds of trading, for a total gain of about 250 francs. Total trading gains
over all 15 rounds in the no-guidance setting average -17 francs.\footnote{Additional analyses (not presented here) reveal that the less-informed investors systematically lose money from their net trades with the more-informed investors. These losses are largely offset by gains from trading with the uninformed specialist. When the latter are eliminated, less-informed investors losses in steady-state are statistically significant.} If a trader were able to avoid the relative over-confidence bias and act as if they were in the guidance setting, their profits would so outweigh the others in the no-guidance condition that they would capture virtually the entire $40 payment that is being split on a pro-rata basis. This is a $20 advantage over earning an average profit in that setting. Thus, the cost of relative over-confidence in the no-guidance setting appears to be quite substantial.

4.4. Additional analysis

We interpret the experimental results in the following way: guidance increases the trading profits of less-informed investors by reducing their confidence. This reduction in confidence causes them to estimate less-extreme security values, which in turn causes them to trade less aggressively against more-informed investors. It is this different trading behavior that ultimately increases trading profits.

To support this interpretation, we conducted a sequence of regression analyses using the difference in TRADING PROFITS in (column 3 of Table 2) as the dependent variable, and treating each cohort average as an independent observation. All variables are defined as in Table 2. The first analysis uses guidance as a binary independent variable and the difference in ESTIMATE BIAS across more- and less-informed traders as a continuous independent variable. We find that guidance is not significant ($p=0.11$, one-tailed), while ESTIMATE BIAS is marginally significant ($p<0.085$). We then include the difference in TRADING BIAS across more- and less-informed traders as an additional continuous independent variable. In this model, both guidance and estimate bias are insignificant ($p>0.3$ for both, one-tailed), and TRADING BIAS is significant ($p=0.043$, one-tailed). After controlling for trading behavior, ESTIMATE BIAS has no effect on trading profits, and after controlling for ESTIMATE BIAS, guidance has no effect on trading profits. This pattern of results confirms that guidance increases TRADING PROFITS of the less-informed by altering their estimates, which in turn alters their trading behavior.

We use a similar analysis to support our assertion that over-confidence affects both estimates and certainty in those estimates. Specifically, we use the difference in TRADING BIAS as a dependent variable, guidance as a binary independent variable, and the difference in ESTIMATE BIAS across more- and less-informed traders as a continuous independent variable. We find that guidance significantly reduces TRADING BIAS ($p=0.021$, one-tailed), even after controlling for ESTIMATE BIAS, which is also significant ($p<0.022$). This indicates that, in addition to making less-informed investors’ estimates less extreme, the guidance manipulation also reduces trading bias by making them less certain about those estimates.

We next examine whether our treatment effects depend on whether less-informed investors have favorable or unfavorable information. As noted above, H1 asserts that, in the absence of guidance, less-informed investors transfer wealth to more-informed investors by buying at high steady-state prices when they hold the more-favorable signal and selling at low steady-state prices when they hold the less-favorable signal. The analyses in the previous section test for the combined effect of these two behaviors. We performed the same analysis separately for the securities for which the less-informed investors held the more-favorable signal and the securities for which the less-informed investors held the less-favorable signal. Though the effects were still significant or marginally significant when the less-informed held the less-favorable signal, the effects were much larger when the less-informed held the more-favorable signal. When the less-informed received the more-favorable information, differences in ESTIMATE BIAS, TRADING BIAS, and TRADING PROFITS were 5.83 francs, 6.82 shares, and -77.47 francs, respectively ($p=0.001$, $p=0.000$, $p=0.002$). When the less-informed received the
less-favorable information, differences in ESTIMATE BIAS, TRADING BIAS, and TRADING PROFITS were 2.51 francs, 1.34 shares, and −25.91 francs, respectively ($p = 0.006$, $p = 0.039$, $p = 0.085$). The less-informed “bought high” more than they “sold low”. This result is particularly interesting in light of the findings of Ganguly et al. (1994). In that paper, market-level price biases are greater when biased estimates exceed unbiased estimates than when the reverse is true. Such asymmetry could arise in their setting because unbiased traders with low estimates cannot engage in short-selling that would bring prices down. In our markets, there is no asymmetry induced by short-selling restrictions. Thus, there may be psychological forces that prevent unbiased investors from short-selling, even when they are permitted to do so.

While our theory suggests that the above results are caused by the relative over-confidence of the less-informed investors, our main experiment never attempted to assess investor confidence. We did not do so in the main experiment because we were concerned that such a direct assessment might affect investors’ trading behavior in the direction of our hypotheses. To provide a more direct assessment of investor confidence, we presented a second group of subjects with the seven securities used in the above analyses and asked them to indicate (1) their estimate of security value, (2) their confidence that the true value lies no more than $10 below their estimate ($p < 0.032$, one-tailed), and (3) the number of shares they would wish to buy at a price equal to (their estimate less $10). The confidence scale ranges from 0 (“not confident”) to 100 (“reasonably confident”). The confidence and number-of-shares-purchased questions were worded in terms of “estimate −$10” to allow comparison of data between subjects who had different estimates. Half of the subjects received only one information signal (“GROWTH” as described above); the other half received three information signals (“GROWTH”, “BOOK”, and “ROE”). Half of the subjects received guidance and half did not. Analysis of variance reveals a significant interaction for subjects’ confidence that the true value lies no more than $10 below their estimate ($p < 0.003$, one-tailed). We therefore examine each of the four simple contrasts for each dependent variable. We start by examining the effects of information without and with guidance. In the absence of guidance less-informed investors provide estimates that are slightly more extreme than those of more-informed investors (24.6 vs 18.5 from the midpoint, $p < 0.186$, two-tailed). They also provide confidence ratings that are similar to those of more-informed investors (59 vs 62, $p < 0.488$, two-tailed). However, in the presence of guidance, the less-informed investors’ estimates are less extreme than those of more-informed investors (18.5 vs 22.3, $p < 0.183$, two-tailed), and their confidence ratings are much lower (49 vs 62, $p < 0.011$, one-tailed). Thus, guidance appears to help less-informed investors to act as if they are less-informed than the more-informed investors.

We also examine the effects of guidance on less- and more-informed subjects. We find that guidance significantly reduces the less-informed investors’ estimate extremity (24.6 vs. 18.5, $p < 0.018$, one-tailed) and confidence (58.9 vs 49.2, $p < 0.022$, one-tailed). However, guidance has no significant effect on either variable for more-informed investors. Taken together, these results confirm that guidance reduces the relative over-confidence of less-informed investors by reducing the confidence of those investors, not by increasing the confidence of the more-informed investors.

5. Discussion

Our experiment investigates welfare losses of less-informed investors and the effect of providing these investors with guidance about the reliability of their information. In our experiment, we find that less-informed investors tend to buy when steady-state prices are high and sell when steady-state prices are low, causing them to transfer wealth to more-informed investors. However, when given guidance regarding the statistical reliability ($R^2$ values) of available information, our experiment indicates that less-informed investors tend to avoid these systematic wealth transfers.
We attribute these results to the over-confidence of less-informed investors relative to the confidence levels of more-informed investors. This relative over-confidence leads less-informed investors to trade too aggressively at prices that are not informationally efficient. Guidance reduces wealth transfers by reducing relative over-confidence. Less-informed investors in real-world stock markets may have many opportunities to learn the reliability of available information. However, to the extent that they do not do so, our results suggest that less-informed investors could be helped by regulations which either reduce their informational disadvantage or which alert them to the extent of their informational disadvantage.

Examining the effect of providing guidance to less-informed investors may also shed light on methods of protecting the welfare of less-informed investors without regulations that require all investors to receive the same information. [The costs of such regulations may exceed their benefits (Scott & Upton, 1991).] Specifically, evidence that guidance on signal reliability reduces wealth transfers would suggest that less-informed investors can protect themselves as long as they have sufficient information about the reliability of available information. For example, the presence of voluminous footnotes along with the currently required clear disclosure that “the footnotes are an integral part of the financial statements” may help protect investors who cannot interpret the footnotes by reducing their over-confidence (thus providing a rough form of task properties feedback by alerting less-informed investors to their informational disadvantage). On the other hand, summary annual reports (which do not include footnote disclosures) might lead recipients to underestimate the extent of additional information that other investors hold.

Allowing some investors to receive information without the knowledge of other investors might cause similar problems. For example, the SEC and FASB have recently considered and rejected proposals that would permit firms to provide financial statements that exclude many important footnote disclosures. Although excluding such disclosures would be unlikely to reduce the level of information understood by less-informed investors (who presumably lack the incentive, motivation or resources to understand the omitted disclosures even if they were provided), it might harm the ability of less-informed investors to assess exactly how much information they do not understand. Our results thus provide evidence supporting the SEC’s decision to maintain full footnote disclosure. Similarly, the FASB has recently invited comment regarding an AICPA committee’s suggestion that, if subsets of professional investors were provided access to more extensive information, market efficiency would ensure that less-informed investors would be price-protected from welfare losses. Our results suggest that market inefficiencies might lead to welfare losses by less-informed investors, unless those investors are made aware of the extent of their informational disadvantage.

It is also interesting to consider the relation between our results and the post-earnings-announcement drift literature (e.g. Bernard & Thomas, 1989, 1990). Because earnings information is very widely disseminated, it is reasonable to suppose that less-informed investors observe earnings, and that more-informed investors observe earnings and other information. If post-earnings-announcement drift is present, and if prices also respond less to information that is less widely distributed, then we would anticipate prices to under-react somewhat to earnings and to under-react even more to other information. Under these circumstances, a less-informed investor could profitably exploit under-reactions to earnings by buying whenever earnings were favorable and selling whenever earnings were unfavorable, regardless of the other information in the market. However, an over-confident less-informed investor will not pursue this strategy. To see why, assume that earnings information (held by all investors) is favorable and that other information (held by only more-informed investors) is even more favorable. A strategy exploiting under-reactions to earnings would entail buying shares, but the favorability of other information will cause the price to rise higher than a less-informed investor believes is justified given only earnings information. Consequently, an over-confident less-informed investor will sell the security,
even though they should buy. The opposite argument holds as well, with over-confident less-informed investors buying shares only when doing so is least likely to be profitable (i.e. when earnings is more favorable than other information). Thus, our results suggest that over-confidence might make it difficult for less-informed investors to exploit known market inefficiencies such as post-earnings-announcement drift.

We also find that guidance is able to reduce welfare losses without reducing price biases. We believe this occurs because price biases are caused primarily by inference errors in early rounds of trading. By later rounds, guidance combined with observations of trading is sufficient to eliminate the relative over-confidence (and resulting greater bias in value estimates) of the less-informed. As a result, although prices remain biased in later rounds, trades by the less-informed do not differ systematically from those by the more-informed, and welfare losses in later rounds are reduced.

Several aspects of real-world financial markets may alter the magnitude of the effects we find in the laboratory. The influence of less-informed investors on steady-state prices depends partly on their wealth. In our markets, less-informed investors have as much wealth as more-informed investors. If less-informed investors have limited wealth, they will have limited effects on steady-state prices. Also, less-informed investors in our markets must trade on their own behalf, rather than retaining the services of more-informed investors to trade for them. Less-informed investors in real markets can choose not to trade actively at all (perhaps investing through mutual funds), and may therefore find it easier to avoid trading biases. However, individual (and presumably less-informed) investors appear to trade quite actively in financial markets, despite the apparent irrationality of doing so (Lee, Shleifer & Thaler, 1991). Given increasingly convincing evidence that financial markets may not be informationally efficient (e.g. Bernard & Thomas, 1989, 1990; Hand, 1990; Sloan, 1996), it seems likely that less-informed investors influence prices and transfer wealth to more-informed investors in real markets. Non-specialist markets might have institutional features that decrease the generality of our results. However, we are not aware of any such features that would do so.

Finally, it is important to recognize that we examine only one way in which informationally-disadvantaged investors might suffer welfare losses — by taking systematically inappropriate trading positions at market prices. Investors can also suffer welfare losses by trading too frequently (portfolio churning), resulting in excessive transactions costs, or by investing in poorly balanced portfolios (Lev, 1988). Future experiments might examine how losses associated with these behaviors are influenced by informational disadvantages and investor over-confidence.

Acknowledgements

We are grateful for helpful comments from John Elliott, Charles Lee, and workshop participants at Duke University, Michigan State University, Northern Arizona University, and the Universities of Arizona, Georgia, Illinois, Iowa, and Waterloo, and for expert research assistance from Jeff Wilks.

Appendix A. Instructions about securities

A1.1. Overview

In this session, security values and trader information are taken from “Value-Line” reports, a service which projects performance and makes investment recommendations.

To construct the securities, we first obtained a sample of all 291 manufacturing firms which made a profit in the fiscal year immediately preceding the publication of a Fall 1993 Value-Line report. We ranked the 291 firms by their “Price/Book” ratio, which is defined as the Fall 1993 price on the day the report was issued, divided by the firm’s book value per share [(assets–liabilities)/shares outstanding] for the preceding fiscal year, which we refer to as fiscal year 1992. We then assigned each firm a “percentile” rank, which represents the percentage of the sample with a lower Price/Book ratio. For example, a firm whose Price/Book
ratio was greater than 34% of the sample firms' Price/Book ratios was assigned a percentile rank of 34.

To construct the securities you will see during this trading session, we selected a representative sample of firms. The value of each security (in francs) is simply equal to that firm's percentile rank for its Price/Book ratio; thus, the higher the firm's percentile rank for the Price/Book ratio, the higher the value. Values range from 0 to 100 francs.

Every investor will receive some information about the firm, which consists of one or more of three ratios which have consistent and statistically significant relationships with the Price/Book ratio. You can use this information to assess the probable percentile rank of that firm's Price/Book ratio. The three ratios are:

1. Return on equity (ROE). A firm's ROE is defined as

\[
\text{ROE} = \frac{1992 \text{ EPS before extraordinary items}}{1992 \text{ Book Value per share}},
\]

where Book Value is (Assets−Liabilities)/Shares Outstanding.

Firms with higher ROE levels tend to have higher Price/Book ratios, because each dollar of book value is generating more cash flow for investors. To provide you with information about ROE, we divided the sample into 11 groups of about 26 firms each. The 26 firms with the lowest ROE levels were assigned an ROE rank of 0, the 26 firms with the next lowest ROE levels were assigned an ROE rank of 1, and so on. The 26 firms with the highest ROE levels were assigned an ROE rank of 10.

2. Growth in ROE (GROWTH). For each firm, Value-Line projects the growth in the firm's ROE. This growth rate is defined as

\[
\text{Growth in ROE} = \frac{\text{Projected 1994 ROE}}{\text{Actual 1992 ROE}} - 1
\]

Firms for which Value-Line assesses high growth tend to have higher Price/Book ratios, because investors expect them to have higher ROE levels in the future. To provide you with information about growth, we split each of the 11 groups defined by the ROE rank into 11 GROWTH ranks. Thus, for firms with an ROE rank of 0, the two or three firms with the lowest GROWTH levels were assigned a GROWTH rank of 0, the two or three firms with the next lowest GROWTH levels were assigned a GROWTH rank of 1, and so on. We then did the same for ROE ranks of 1, 2, 3 and so on. Note that this construction ensures that GROWTH and ROE are completely independent.

3. Book Value per Share (BOOK). Firms with higher Book Value per share tend to have lower Price/Book ratios, in part because they use accounting methods which inflate book value relative to true value.

To provide you with information about book values, we followed the same procedure we used for GROWTH. We split each of the 11 groups defined by the ROE rank into 11 BOOK ranks. Thus, for firms with an ROE rank of 0, the two or three firms with the lowest BOOK levels were assigned a BOOK rank of 10, the two or three firms with the next lowest BOOK levels were assigned a BOOK rank of 9, and so on. We then did the same for ROE ranks of 1, 2, 3 and so on. Note that this construction ensures that BOOK and ROE are completely independent.

Also, note that firms with high Book Values are given low (negative) BOOK rankings, to reflect the fact that high Book Values are associated with low Price/Book ratios. Thus, as with ROE and GROWTH, high BOOK ranks tend to be associated with high Price/Book ratios.

Appendix B. “Guidance” provided to subjects in guidance treatments

B1.1. Reliability of ROE, GROWTH and BOOK

Each of the three signals are able to predict some of the variation in Price/Book percentiles (which determine security values). However, some of the signals have more explanatory power than others. To give you some guidance on the signals’ explanatory power, we ran “linear regressions,” which use statistical techniques to predict Price/
Book percentiles from the values of ROE, GROWTH and BOOK. The table below reports the “$R^2$” values of the regressions, which reflect the percentage of the variation in Price/Book percentiles that is explained by the signals.

<table>
<thead>
<tr>
<th>Signals</th>
<th>Percentage of variation in Price/Book percentiles explained by signals ($R^2$)</th>
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</thead>
<tbody>
<tr>
<td>ROE only</td>
<td>40.5</td>
</tr>
<tr>
<td>GROWTH only</td>
<td>15.7</td>
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<tr>
<td>BOOK only</td>
<td>6.7</td>
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<tr>
<td>ROE, GROWTH and BOOK</td>
<td>60.7</td>
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</tbody>
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Note that ROE alone explains a great deal of the variation in Price/Book percentiles (40.5%). GROWTH and BOOK alone explain very little (15.7 and 6.7%).

Appendix C. Laboratory stock market instructions about trading

C1.1. Overview

In this series of Laboratory Stock Markets, investors trade shares of a number of securities. Each security has a value denominated in a fictitious currency called “francs.” When you buy and sell shares of the security, you either gain or lose francs. These francs are converted into cash at the end of the session. These instructions describe the general rules regarding trading in the Laboratory Stock Market. Instructions describing the specific securities to be traded in a specific session will be handed out at the beginning of that session.

C1.2. Value, gains and losses

Each security you will trade in these markets pays a dividend at the end of trading. The amount of this dividend is called the “value” of the security. Although there may be changes in the prices at which investors trade shares, the value of a security never changes. There are two ways to make money in this market. The first is by trading profitably. Every time you buy a share of the security, you are giving up the right to receive the dividend. Therefore, the amount you gain or lose in francs in each round is given by the following equations:

Gain from buying = (Value − Purchase price) × (No. of shares bought)

Gain from selling = (Sales price − Value) × (No. of shares sold)

The second way to make money in the market is by estimating the value of the security accurately in the first and last round of trading. If your estimate is 30 francs or more from true value, you do not earn additional francs. However, estimating a value within 30 francs of the true value earns you (in francs) the amount given by the following equation.

Gain from estimate = 300 − (10 × |ESTIMATE − VALUE|).

C1.3. Trading

You will trade each security for 15 rounds. In each round you will estimate the value of the security. After you enter your estimate you will learn the price at which you can buy or sell. If your estimate is greater than the price, you may buy up to 10 shares at the stated price. Similarly, if your estimate is less than the price, you may sell up to 10 shares at the stated price. If your estimate is exactly equal to price you are not permitted to trade in that round. After all traders have made their decisions, you will learn how many shares were bought and sold at the current price. You can use this information to infer information that the other traders have about value. The trading process is then repeated. At the end of the 15th round of trading, you will learn the true value of the security. You will then begin trading a new security.

C1.4. Prices

The starting price for the security is always 50 francs. The price change from one round to the next is determined by the imbalance, defined as the
number of shares bought minus the number of shares sold. If the imbalance is positive (traders are buying) in one round, the computer will post a higher price in the next round. Similarly, if the imbalance is negative (traders are selling) in one round, the computer will post a lower price in the next round. Your estimates have no influence on the posted price, but may influence whether you can buy or sell at the posted price.

The size of the price change depends on the size of the imbalance and on previous price movements. The computer moves the price more when the imbalance is more positive or more negative. However, the computer will use previous imbalances to limit current price movements. For example, if there was a positive imbalance at a price of 60, the computer might move upward to 85. However, even if sells greatly outnumber buys at 85, the price will not drop below 60 in the next round, because traders have already shown they believe that 60 is too low a price. The price would only fall below 60 if investors continued to sell at prices only slightly above 60.

C1.5. Converting francs to dollars

Your winnings will be determined by the number of francs you won, relative to the average francs won by traders in other markets holding the same information you hold. This means that your winnings are not affected by whether the other traders in your group do well or poorly. It is entirely possible that all four traders in your market will do well (or poorly) relative to traders in other markets. No matter what happens, you will receive at least $5 for completing the session.

I consent to participate in this experiment, and agree to abide by all of the rules determined by the experiment coordinator throughout my participation. I recognize that: (1) if I breach any of the rules governing the market, I forfeit my right to any money I might have earned by participating; (2) I have the right to leave the experiment at any time, without penalty, but that in doing so I forfeit my right to any money I might have earned by trading; (3) this experiment has been approved by the Cornell University Committee on Human Subjects as research that uses no deception of any kind.

Signature Date

References


Griffin, D., & Tversky, A. (1992). The weighting of evidence...


