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Limited attention, information disclosure, and financial reporting

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Abstract

This paper models firms' choices between alternative means of presenting information, and the effects of different presentations on market prices when investors have limited attention and processing power. In a market equilibrium with partially attentive investors, we examine the effects of alternative: levels of discretion in *pro forma* earnings disclosure, methods of accounting for employee option compensation, and degrees of aggregation in reporting. We derive empirical implications relating *pro forma* adjustments, option compensation, the growth, persistence, and informativeness of earnings, short-run managerial incentives, and other firm characteristics to stock price reactions, misvaluation, long-run abnormal returns, and corporate decisions.

JEL classification: G12; G14; G18; G28; G38; M41

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1. Introduction

Firms and regulators care not just about the information made publicly available to investors, but the form in which it is revealed. One issue of great concern to practitioners is whether information items should be *recognized* as part of earnings, or merely *disclosed* as a footnote. Another is the prominence with which different kinds of information are displayed in financial statements. There is also intense concern as to the form of disclosure, even when the information content of the alternative formats is identical. Evidently regulators and commentators think that investors are imperfect processors of publicly available information. Such concerns are reflected in the structure of accounting regulation, and in politically charged debates over such issues as merger accounting, whether employee option compensation should be expensed, and to what extent firms should be free to make *pro forma* disclosures that differ from GAAP definitions of earnings.

In contrast, in existing analytic research on financial reporting, the choice between recognition versus disclosure, and between equivalent forms of disclosure or reporting, has no effect on investor perceptions. In existing models of reporting, investors are fully rational, and market prices are set efficiently to reflect all publicly available information.[2] This approach has provided important insights into the interplay of financial reporting, optimal contracts, and capital markets. However, from the perspective of this traditional approach, the passionate interest of practitioners in the regulation of informationally equivalent disclosures and reports is a major puzzle.[3]

This paper offers an approach to the analytical modeling of financial reporting and disclosure that encompasses these issues. Our approach departs from existing theory in assuming that investors have *limited attention* and processing power. An immediate but far-reaching consequence of limited attention is that informationally equivalent disclosures can have different effects on investor perceptions, depending on the form of presentation. Limited attention has implications for non-equivalent disclosures as well.

[2] Some models of disclosure that are embedded in rational expectations settings allow for liquidity shocks, but the usual interpretation of these settings is that the market is efficient with respect to public information and that liquidity trading reflects unmodeled portfolio rebalancing considerations rather than imperfect rationality. In principle, the form of presentation of an information item could signal other information possessed by the firm to investors. However, it is not clear what the cost differentials to different firm types would be that would make such signalling credible. It is also possible that owing to political or contracting constraints, informationally equivalent disclosure/reporting regimes may matter to market participants. This raises the question of whether such constraints themselves derive from limited attention and processing power.

[3] For example, SFAS 130 "Reporting Comprehensive Income," which was issued in 1997, shifted the prominence of the reporting of certain components of income without introducing any new recognition or measurement rules—see Hirst and Hopkins (1998). As another example, see the discussion of the political battle over the expensing of employee share option compensation in Section 5. Dechow and Skinner (2000) comment that in contrast with the views of many academics in the accounting field, regulators would probably remain concerned about earnings management even if financial statements were sufficiently detailed to allow investors to undo managers' accounting choices fully.

In our model, owing to limits to investor attention, information that is presented in salient, easily processed form is assumed to be absorbed more easily than information that is less salient, or that is only implicit in the public information set. Thus, investors neglect relevant aspects of the economic environments they face. For example, investors may neglect the distinctive features of different divisions of a diversified firm, or may not adequately adjust their interpretations of disclosures to take into account the strategic incentives of firms to manipulate observers' perceptions. We model these possibilities by assuming that each investor has only a probability of attending to the relevant consideration.[4] Furthermore, we assume that investors are risk averse, so that highly attentive investors are limited in the extent to which they are willing to bear risk in order to exploit mispricing.

Inattention seems foolish in our setting, as inattentive investors lose money by ignoring aspects of the economic environment. However, if time and attention are costly, such behavior may be reasonable.

To display some of the range of relevance of limited attention for reporting and for reporting-related disclosure, we apply this approach to three specific contexts. These applications show how the approach can help explain puzzling stylized facts, generate untested empirical implications, and suggest possible considerations for policy. The modelling is stark, and we hope will stimulate more general analyses of the consequences of limited attention and reporting choices.

The first application is to *pro forma* earnings disclosure. We consider the effect of discretion in firms' disclosure of non-GAAP earnings measures in *pro forma* earnings announcements. We find that *pro forma* disclosures bias investors' perceptions upwards, yet can make stock prices more accurately reflect fundamental value.

The second application is to an issue of timing allocation, the possible reporting of employee stock option compensation as an expense at the time that the options are granted. We take as a premise that the compensation must be disclosed up front, and examine how the failure to expense this compensation prior to option exercise can cause overvaluation, and induce a relation between the size of this compensation and subsequent abnormal stock returns. However, the analysis also predicts that full expensing of these options would cause market *under*valuation, consistent with the vigorous protests of high-tech firms against the expensing of these options. Surprisingly, the analysis further implies that the expensing rule that supports accurate market valuations depends on the persistence of earnings. A similar implication would also apply more generally to the expensing of accounting items when lumpy expenditures generate benefits over several subsequent reporting periods.

[4] An interesting case of this is neglect of a newly arrived information signal. We do not examine simple neglect of a new signal in this paper, but this possibility can be captured in the special case of extreme underreaction in the 'heuristic trader' models of securities trading of Fischer and Verrecchia (1999) and Verrecchia (2001), which we discuss further below.

The final application is to an issue of aggregation in financial reporting. We examine the effects on investor perceptions of segment reporting versus aggregate reporting versus divestiture in a diversified firm. We find that during periods of high foreseen general earnings growth, investors who focus on the recent growth rate of a firm's aggregate earnings will tend to overweight low growth segments at the expense of high growth segments, and in consequence will tend to undervalue the firm. More importantly, the model suggests a direction for analyzing reporting aggregation when attention is limited.

There is a remarkable disjunction in the accounting literature between the experimental research versus analytical models of financial information processing. Experimental research has provided a provocative array of evidence that both naive and sophisticated investors and professional analysts are systematically biased in their interpretation of accounting data, and that these biases affect market prices. As Libby et al. (2002) describe the evidence,

> … the information that decision makers rely upon in their judgments is limited, and the information emphasized clearly changes depending on the financial judgment being made, and other elements of the environment. In fact, awareness of cosmetic differences (and ability to 'do the math') does not ensure full consideration of their implications for valuation. The same is true of knowledge of management's tendency to opportunistically employ vague reporting standards or analysts' tendency to bias their reports.

Furthermore, in an insightful recent discussion, Bloomfield (2002) suggests that failures in information processing can help explain empirical patterns related to accounting information.

In contrast, analytical models of disclosure and reporting, often published in the same journals without reference to the experimental literature, have almost uniformly assumed full rationality of decisions and pricing. One goal of this paper is to begin the search for complementarities between the insights derived from experimental study and through analytical modeling in accounting.

There are some important exceptions to the assumption of perfect information processing in accounting models of reporting or disclosure. Bushman et al. (1996) analyze the effects of SEC proposals for two-tiered financial reporting when investors process financial reports in order to generate private information. Our focus is not on skill in generating new private signals, but on investors' failure to take into account certain aspects of their decision environment.

In the heuristic trading models of disclosure of Fischer and Verrecchia (1999) and Verrecchia (2001), 'heuristic investors' are assumed to either under- or over-react to an information signal. Fischer and Verrecchia then explore the conditions under which heuristic investors can survive in competition with rational Bayesian investors. They offer a general analysis of the profitability of different forms of irrational trading. Their analysis implicitly allows for limited attention by allowing for the possibility that some investors underreact to the public signal.

We build upon these important contributions by allowing for forms of investor errors not present in the heuristic trader models. In our approach, errors derive from

a failure of investors to attend to some non-salient or hard-to-process aspect of the economic environment, which need not be a newly arrived signal (see also footnote 4). Our modeling focus is also different; we examine the effects of limited attention in specific disclosure and reporting contexts. However, in order to address the survival issue emphasized by Fischer and Verrecchia, in Section 7 we discuss why limited attention is likely to remain important for capital markets in the long-term.

The general approach followed here is similar in spirit to that of Hirshleifer et al. (2002), who examine the decision of an informed party of whether to disclose. A fraction of the audience fails to attend either to a disclosed signal, or to the failure of the informed party to disclose. In their model the former discourages disclosure whereas the latter encourages it, so that disclosure may be incomplete even if there are no proprietary costs. Their approach implies that limited attention can affect the prices of products or securities. Other recent papers model how limited learning capacity affects asset price comovement (Peng and Xiong, 2002a), and how delayed processing of new information affects the dynamics of asset price volatility (Peng and Xiong, 2002b). However, none of these papers specifically examines accounting disclosure and reporting choices.

The remainder of the paper is structured as follows. Section 2 discusses the psychology of limited attention. Section 3 outlines the general setting. Section 4 analyzes the disclosure of *pro forma* earnings. Section 5 analyzes the reporting of managerial option compensation. Section 6 analyzes the effects of aggregation in reporting with reference to segment reporting and divestiture. Section 7 examines whether limited attention can affect market prices. Section 8 discusses the relation of the model to existing research in behavioral finance. Section 9 concludes.

2. Review of theory and evidence on limited attention and information processing

Limited attention is a necessary consequence of the vast amount of information available in the environment, and of limits to information processing power. Attention must be selective and requires effort (substitution of cognitive resources from other tasks; see, e.g., Kahneman, 1973). Several well-known decision biases, including narrow framing (a tendency to analyze problems in a specific context without adequately reflecting broader considerations) probably derive from limits to attention and processing power.

Attention is required both to encode environmental stimuli (such as a corporate information disclosure), and to process ideas in conscious thought (as in the analysis of a corporate disclosure or of a failure of a company to disclose). As discussed in Fiske (1995), the encoding process involves taking external information and representing it internally in a way that enables its use. Conscious thought involves a focus on particular ideas or memories to the exclusion of others. For example, if an individual focuses on understanding the implications of the financial report of one firm, he may be unable to study another firm carefully at the same time.

Attention tends to be drawn to stimuli that are goal-related, but can also be misdirected. For example, attention is drawn to vivid stimuli.[5] Some stimuli tend to be perceived and encoded more easily than others. The *salience* of a stimulus is its 'prominence,' tendency to 'stand out', or its degree of contrast with other stimuli in the environment. The effects of salience are "robust and wide-ranging" (Fiske and Taylor, 1991, Chapter 7). Salience influences judgments about causality, the importance of a stimulus, and how extreme it is. For example, if the salience of a footnote disclosure is not high, some investors may fail to process it.

Furthermore, people tend to underweight abstract, statistical, and base-rate information (see, e.g., Kahneman and Tversky, 1973; Nisbett and Ross, 1980). This suggests that the amount of attention that observers direct toward a disclosure or aspect of the economic environment need not correspond closely to its economic importance.

How attention is directed in conscious thought depends on the ease with which memories are accessed. In the *availability heuristic* (Tversky and Kahneman, 1973), individuals assess the frequency or likelihood of a phenomenon according to their ability to retrieve confirmatory examples from memory. To the extent that facts that are more salient or vivid are more available, attentional biases can bias beliefs.

A literature in psychology has examined how subjects learn by observation over time to predict a variable that is stochastically related to multiple cues (see, e.g., Kruschke and Johansen, 1999). A pervasive finding is that *cue competition* occurs: salient cues weaken the effects of less salient ones, and the presence of irrelevant cues causes subjects to use relevant cues and base rates (unconditional frequencies) less.

Limited information processing capacity tends to induce individuals to use information in the form it is displayed rather than modifying it appropriately (see, e.g., Slovic, 1972; Payne et al., 1993). Libby et al. (2002) discuss how a reliance on category structures reduces the costs of processing information, but can also induce errors such as functional fixation.

Libby et al. (2002) and Maines (1995) provide excellent surveys of experimental research on financial information processing. Libby, Bloomfield, and Nelson remark of early literature on the processing of accounting information by investors and analysts that "Some participants in nearly every study of this type demonstrate some degree of functional fixation; they do not fully adjust for differences in the effects of accounting alternatives on the bottom line…," and that "…we have begun to understand that placement, categorization, and labelling all play a role in the simplifications that even professional analysts apply when evaluating accounting information."

Several experimental studies have found that the disclosure of equivalent information about a firm presented in different ways affects the valuations and

[5] Vividness is greatest for concrete descriptions and scenarios, stories about personal experiences, information that falls into an easily summarized pattern, stimuli that trigger emotional responses, or which are more 'proximate in a sensory, temporal or spatial way' (Nisbett and Ross, 1980, p. 45).

trades of investors and even experienced financial analysts.[6] There is also evidence that individuals fail to make use of all publicly available information (see, e.g., Lipe, 1998 on the use of covariances).

The evidence described so far in this section suggests that limited attention may affect behavior and prices in actual capital markets. Whether it in fact does so is part of the larger issue of the extent to which securities markets are efficient in processing publicly available information. As emphasized by Kothari (2001), some findings of apparent market inefficiency in existing literature may be artifacts of flaws in methodology. Potential sources of spurious effects include problems in risk measurement (see, e.g., Franks et al., 1991), data issues such as survivorship bias, and the effects of skewness of financial variables (Kothari et al., 2002). This said, there appears to be a set of 'anomalies' (patterns of return predictability) that have so far proven stubbornly hard to explain from an efficient markets perspective, including post-earnings announcement drift, the accruals anomaly, and stock return momentum.

With regard to investor attention, a vast body of evidence from short-window event studies confirms that stock markets react immediately to relevant news. This suggests, at a minimum, that some investors do direct their attention very rapidly to relevant announcements. Short-window event studies do not, however, resolve the question of whether there is under- or over-reaction in the initial response. Such studies therefore leave open the question of whether there is a substantial body of actively participating investors who fail to attend to public information appropriately.

A large number of long-horizon event studies have provided evidence suggesting under-reaction to many (though not all) kinds of public news events (see the review of Hirshleifer, 2001). However, there has been a great deal of debate as to the appropriate methodology for testing market efficiency using long-run abnormal returns; see, e.g., Barber and Lyon (1997), Kothari and Warner (1997), Fama (1998), Loughran and Ritter (2000), and Hirshleifer (2001).

Post-earnings announcement drift (Ball and Brown, 1968; Bernard and Thomas, 1989) suggests that prices underreact to earnings news, as would occur if some participating investors failed to react fully to such announcements. Such an effect could be a spurious consequence of mismeasurement of the expected return benchmark. However, the effect is concentrated at subsequent earnings announcement dates. To explain the returns on these dates as large (in absolute value) daily risk premia would seem to require large (in absolute value) daily covariances with aggregate market factors.

[6] Such effects have been found in the context of recognition versus disclosure of pension liabilities (Harper et al., 1987), classification of the same hybrid financial instrument as debt, equity or mezzanine financing in the balance sheet (Hopkins, 1996), the previewing of negative earnings news with an adverse qualitative preannouncement (Libby and Tan, 1999), and the use of the purchase method of accounting for business combinations with the premium ratably amortized versus the use of pooling-of-interest (Hopkins et al., 2000) and the inclusion of other comprehensive income items in the income statement rather than in the statement of changes in shareholders' equity (Hirst and Hopkins, 1998), as well as in market settings (Dietrich et al., 2001).

The negative relation of accruals to subsequent stock returns, and indications that firms manage earnings to exploit investor perceptions (Sloan, 1996; Teoh et al., 1998a, b; Xie, 2001), suggest that some investors fail to take into account the information contained in the breakdown of earnings between cash flow and accruals. Similarly, there is evidence suggesting that analysts tend to neglect relevant financial statement information (e.g., Abarbanell and Bushee, 1997; Teoh and Wong, 2002). The finance and economics literatures provide a further body of evidence consistent with limited attention affecting securities prices (see, e.g., the evidence reviewed by Daniel et al., 2002).[7]

A literature on accounting methods has provided evidence that firms' accounting choices are consistent with an attempt to manage the perceptions of functionally fixated investors; investors have some ability to invert out the implications of different accounting methods for value (see the survey of Kothari, 2001), but that over long horizons differences in accounting methods are associated with abnormal stock returns. The extent to which these returns indicate market inefficiency or problems in measuring long-run returns is as yet unresolved.

Several recent papers have provided evidence suggesting that investors weight information that is recognized more heavily than information that is disclosed in footnotes. Amir (1993) found that footnote disclosure of post-retirement benefits was underweighted by investors until the policy discussions leading up to SFAS 106, which made the long-term costs of these benefits more salient. In Aboody (1996), investors valued recognized write-down information more strongly than disclosed write-down information in the oil and gas industry. Davis-Friday et al. (1999) found some modest evidence that recognized non-pension retiree benefits were weighted more heavily in market prices than disclosed liabilities among SFAS No. 106 adopters.

There is other evidence suggesting that investors' and analysts' assessments are influenced by the format and salience with which public signals are presented. For example, Hand (1990) found that the reannounced gains from debt-equity swaps in quarterly earnings announcements were significantly related to mean abnormal returns. Schrand and Walther (2000) provide evidence that managers strategically select the form of the prior-period earnings benchmark when announcing earnings. Prior period special gains were more likely to be mentioned than prior period special losses in the sample, apparently to lower the benchmark for current-period evaluation. Miller (2002) finds that firms at the end of periods of sustained earnings increases shift from long-term forecasts to short-term forecasts, thereby deferring the need to forecast adversely. Plumlee (2003) finds that analyst forecasts of effective tax rates impound the effects of complex tax-law changes less accurately than less complex changes.

[7] Perhaps most striking is that stock prices react to news that is already public information (Klibanoff et al., 1998; Huberman and Regev, 2001; Ho and Michaely, 1988), and to confusions in ticker symbols between stocks Rashes (2001). More broadly, Hong et al. (2002) report evidence that industry stock returns lead aggregate market returns, potentially consistent with gradual diffusion of information about fundamentals across markets.

3. The general setting

We assume that each of a continuum of investors has only a probability of being attentive to a given signal or aspect of the economic environment. We refer to those that end up attending to the consideration as attentive, and the others as inattentive. We denote the fraction that turn out to be inattentive as f.[8] They form their beliefs using only a subset of all publicly available information, broadly construed. Investors may ignore some existing mechanical feature of the economic environment, or may neglect strategic incentives for managers to mislead. For example, in our *pro forma* earnings application, some investors ignore the fact that the firm can strategically adjust *pro forma* earnings in an 'inappropriate' way. We assume that inattentive investors, apart from the specific feature of the environment that they ignore, update beliefs as rational Bayesians. Fraction $1-f$ are attentive. They form expectations rationally and with full attention to all publicly available information.

Fischer and Verrecchia (1999) and Verrecchia (2001) have emphasized that investors who are modeled as influencing price should be able to earn enough profits to survive as important players in a capital market. This is the case in our model for the simple reason that all investors are ex ante identical—everyone has limited attention. More generally, if investors differ in their probability of attention, a question arises of whether only the most attentive survive. The literature on long-run survival suggests that, for several reasons, imperfectly rational investors can under some circumstances remain influential in the long run; see Section 7. Here we offer an alternative, very simple argument. Those who devote more cognitive resources to a particular attentional arena need not do better overall, because of the cost of withdrawing these resources from some other activity. For example, attention demands time, which has a monetary opportunity cost.

The probability that an investor fails to identify and process some aspect of the economic environment correctly, f, can be modeled as a decreasing function of the resources expended on attending to that sector, $f'(c)<0$. (The problem can be ameliorated in part if an individual can hire an intermediary to pay attention on his behalf; nevertheless, individual attention is needed to choose an intermediary well, and even intermediaries are not infinitely attentive; see the discussion at footnote 25.) When reducing f is costly, it is fairly evident that a positive level of f can survive in long-term equilibrium, so for brevity we take f as exogenously given.

There are three dates. At date 0 prior expectations are formed. At date 1, public information arrives about firm value or its components. There is no private information in the model. At date 2 the terminal payoff is realized and the firm is liquidated.

Previous authors have examined static models in which there are two types of investors, rational and imperfectly rational, all of whom are risk averse expected utility maximizers, but in which the imperfectly rational investors optimize with respect to incorrect beliefs. A standard finding in the literature is that, in equilibrium,

[8] Inattention could be viewed as meta-rational if there are costs of attention, but is not consistent with the costless rationality assumption traditionally employed in accounting and financial models.

prices reflect a weighted average of the beliefs of the rational and irrational traders, as adjusted by a risk premium (see, e.g., Daniel et al., 2001). So long as each group has significant risk-bearing capacity, both influence prices significantly. This result does require risk aversion, in order to limit arbitrage, but does not require market frictions.

As a preliminary building block for the subsequent analysis we will verify in our setting that the market valuation of the firm reflects a weighted average of the beliefs of investors who attend fully or partially to the economic environment of the firm. In doing so, we assume that individuals do not fully discount for their imperfect attention in forming expectations. Without this assumption, an individual who knew he was inattentive to a relevant information item could, for example, choose not to trade.

There are three motivations for such imperfect adjustment. First, if the only individuals to trade were those who attended perfectly to all relevant information, in real markets there would be no trade, because in practice the set of potentially relevant and possible ways to process it are unlimited. Of course, individuals will tend to leverage their attention by focusing on more important information items. However, it is often hard to know how important an item is until it is carefully processed.

Second, the same constraints on processing power and memory that make it hard to attend to an aspect of the environment also make it hard to compensate optimally for the failure to attend to an item. The fact that the presentation format of decision problems affects choices indicates not just that attention and processing power are limited, but that individuals are unable to compensate optimally for these limitations.

Third, a well-documented and far-reaching psychological findings is that individuals tend to be overconfident. An overconfident individual may wrongly think that he has already taken into account all the important considerations. Such an individual may not perceive the urgency of working hard to adjust for biases (on overconfidence and poor use of outcome feedback in evaluating judgment accuracy overconfidence, see Einhorn and Hogarth, 1978; Einhorn, 1980).

There is other evidence supportive of the proposition that people fail to compensate adequately for the consequences of limited attention. For example, if individuals were on the whole highly sophisticated they would largely debias the availability heuristic (see Section 2) of Tversky and Kahneman (1973) by downgrading their frequency estimates for items that are easy to recall because of vivid, salient characteristics (as opposed to high frequency in the environment). More specifically, experimental study shows that the presentation of one-sided arguments and evidence to subjects (call 'jurors') asked to judge a legal dispute were biased in favor of the side they heard (Brenner et al., 1996). As the authors state, "The results indicate that people do not compensate sufficiently for missing information even when it is painfully obvious that the information available to them is incomplete." Furthermore, individuals tend to underweight the probabilities of event contingencies that are not explicitly available for consideration; e.g., in a list of

possible causes of an event, the probability of 'other causes' is underestimated (Fischoff et al., 1978).

We therefore assume that an individual who neglects some aspect of the economic environment does not update his beliefs in complete deference to the market price as determined by others who are more attentive. He may inattentively fail to reason sufficiently about why the market price differs from his own valuation. Even should an inattentive trader take note of a seemingly discrepant market price, he may not 'come to his senses' if he thinks that it is other investors who are imperfectly rational.[9]

In our model, since no investor has private information, a fully rational individual has nothing to learn from market price. An inattentive individual who mistakenly thinks he is processing information fully will also think he has nothing to learn from market price. We therefore assume that inattentive investors do not update their beliefs based upon market price.[10] Similar results would hold so long as some disagreement remains between the attentive and inattentive investors, i.e., inattentive investors do not completely abandon their beliefs in favor of the market price.

Individuals are identical except that some fail to attend to and accurately process all available information. There are no private information signals nor any noise/liquidity shocks. Nevertheless, in equilibrium there is trade owing to imperfect rationality. Let a superscript of $\phi = \kappa$ or ρ denote a variable based upon inattentive or attentive (rational) beliefs respectively. Investors have mean-variance preferences,

$$E_1^{\phi}[C] - \frac{A}{2}\,\mathrm{var}_1^{\phi}(C), \tag{1}$$

where C is terminal consumption, a 1 subscript denotes the availability to the individual (though not necessarily used by the individual) of date 1 information, and A is the coefficient of absolute risk aversion. (Such preferences are consistent with the combination of normality of returns and Constant Absolute Risk Aversion (CARA) utility.)

We assume an initial wealth endowment (i.e., claims to terminal consumption) of W^0 and the per capita endowment of the single risky security is x_0. At date 1, the individual can buy or sell the security in exchange for 'cash' (claims to terminal consumption) at price S_1. The position in the security he attains is denoted x. We denote the terminal payoff of the security as S_2. Then an individual's consumption is

$$C = W^0 - (x - x_0)S_1 + xS_2. \tag{2}$$

[9] More generally, some inattentive investors may realize they are inattentive, or could be awakened by the discrepancy enough to realize that they should passively defer to market price. However, so long as some inattentive investors lack such self-awareness, results similar to those derived here will obtain.

[10] In the spirit of perfect Bayesian equilibrium concept, observing the 'wrong' price is like an off-equilibrium event that should never occur, in which case such a failure to update can be consistent with equilibrium. In a setting that allowed for liquidity shocks or noise traders, the limited attention investor could attribute price fluctuations to noise rather than to his own inattention.

Thus, an individual of type ϕ solves

$$\max_{x^{\phi}} x^{\phi}(E_1^{\phi}[S_2] - S_1) - \frac{A}{2}\mathrm{var}_1^{\phi}(x^{\phi}S_2). \tag{3}$$

3.1. Equilibrium as a function of investor perceptions

Differentiating the objective with respect to x^{ϕ}, equating to zero and solving yields

$$x^{\phi} = \frac{E_1^{\phi}[S_2] - S_1}{A\,\mathrm{var}_1^{\phi}(S_2)}. \tag{4}$$

Market price is determined by the security market clearing condition

$$fx^{\kappa} + (1-f)x^{\rho} = x_0. \tag{5}$$

Substituting for x^{κ} and x^{ρ} from (4), and solving for S_1 gives

$$S_1 = \kappa E_1^{\kappa}[S_2] + (1-\kappa)E_1^{\rho}[S_2] - \frac{Ax_0}{\alpha^{\kappa} + \alpha^{\rho}}, \tag{6}$$

where

$$\alpha^{\kappa} \equiv \frac{f}{\mathrm{var}^{\kappa}(S_2)}, \quad \alpha^{\rho} \equiv \frac{1-f}{\mathrm{var}_1^{\rho}(S_2)}, \quad \kappa \equiv \frac{\alpha^{\kappa}}{\alpha^{\kappa} + \alpha^{\rho}}. \tag{7}$$

By normality, κ is a constant independent of the signal realizations used by investors to condition beliefs.

The final term in (6) is the risk premium that the security earns by virtue of being in positive net supply ($x_0 > 0$). Nothing in our analysis requires risk premia, so without loss of generality we eliminate this nuisance term by setting $x_0 = 0$ to obtain

$$S_1 = \kappa E_1^{\kappa}[S_2] + (1-\kappa)E_1^{\rho}[S_2]. \tag{8}$$

This confirms that in equilibrium prices are a weighted average of the beliefs of different investors, with weight κ on inattentive investors and $1-\kappa$ on attentive ones. By (7), ceteris paribus α^{κ} and κ are increasing in f. Thus, the greater the likelihood of each investor being inattentive, the greater the weight that inattentive investors play in determining prices. In this setting, rational investors exploit a trading strategy that earns predictable abnormal returns relative to fully rational asset pricing benchmark. Nevertheless, fully attentive investors do not completely arbitrage away the mispricing generated by inattentive investors, because doing so is risky.[11]

Although (8) is not surprising in view of recent literature in behavioral finance, it indicates that some highly prevalent casual intuitions in the accounting literature about price-setting are mistaken. For example, it is often argued that even if there are irrational investors, the 'marginal investor' is rational, so that prices must be set rationally. However, under perfect markets, *all* investors are marginal; as the κ

[11] For example, if inattentive investors overvalue firms with non-expensed employee option grants, and if most high-tech firms were issuing such options, then an attentive investor who seeks to arbitrage the mispricing bears non-diversifiable risk associated with the industry factor.

weights above demonstrate, the behavior of all investor groups in equilibrium affect prices. Specifically, the beliefs of naive investors will affect prices unless naive investors are infinitely risk averse, sophisticated investors are risk neutral, or there are no naive investors in the trading population. Intuitively, securities prices are determined as an equilibrium of supply and demand. As is standard in microeconomic theory, market price is determined by the aggregate of all demands in the market, not just by the demands of some 'marginal' group of consumers.

The intuition behind the ubiquitous idea that rational investors must dominate price is that if there is mispricing, rational investors have an incentive to exploit it, and in the process of trading against mispricing arbitrage it away. However, as Eq. (8) indicates, this ignores the flip side of the coin. If prices were set solely by the rational investors, imperfectly rational investors would perceive a profit opportunity to trade against what they regard as mispricing. If all investors are risk averse, the outcome, as in (8), reflects a weighted average between these disagreeing perceptions.[12]

3.2. Specification of limited attention

Let the public information set possessed at date 1 by investors be $\psi = (\psi^1, \psi^2, \ldots, \psi^K)$, where the ψ^k's are a set of K public information items, $k = 1, \ldots, K$, and subscripts for date 1 on all variables are suppressed. For example, ψ^k could be the date 1 earnings level ε_1. It is assumed that all date 1 cash has already been paid out as dividends at the start of date 1, so that the market valuation of the firm at the end of date 1 involves forming an expectation of the terminal cash flow to be generated and passed on to shareholders.

There is a structural relation between information ψ and the terminal cash flow c_2, which we summarize as

$$c_2 = H(\psi^1, \psi^2, \ldots, \psi^K; p^1, p^2, \ldots, p^N) + \upsilon, \tag{9}$$

where $p = (p^1, p^2, \ldots, p^N)$ is a vector of parameters that are either directly publicly observable, or which a rational attentive individual can infer from the structure of the market and the implied equilibrium; and where $E^\rho[\upsilon] = 0$ with υ independent of ψ and p. We denote the rational expectation of the terminal cash flow as S_1^ρ,

$$S_1^\rho(\psi; p) \equiv E[c_2|\psi; p] = H(\psi^1, \psi^2, \ldots, \psi^K; p). \tag{10}$$

Limited attention modifies this expectation in two ways. First, individuals may assign the wrong probability distributions to the information signals, $\psi^k \sim g^k(\psi^k)$, where the perceived probability distribution g^k differs from the true one. As a special case, probability may all be loaded on particular values. In other words, the observer

[12] Eq. (8) differs somewhat from the pricing equations in the heuristic trader models of Fischer and Verrecchia (1999) and Verrecchia (2001), which allow for non-competitive price effects and liquidity trading. Here, (8) is a building block for the subsequent analysis in which the market price is a weighted average of investor beliefs. Kandel and Pearson (1995) provide evidence supportive of prices reflecting average trader perceptions.

may set one or more elements of ψ equal to specific 'simple' values,

$$\psi^k = (\psi^k)', \quad k = J, J+1, \ldots, K,$$

where $(\psi^k)'$ are specified values. Which parameters are fixed, and the levels of the specified values can depend on accounting choices. For example, ψ^2 can be the level of a publicly visible cost which the firm has committed to at date 1, but which is not incurred until date 2. An investor who does not attend neglects the cost and sets $\psi^2 = (\psi^2)' = 0$. The expensing of this cost at date 1 may increase the probability that an investor attends to it. Thus, the framework can capture the effect of accounting allocation timing on investor perceptions.

Second, the investor may simplify the parameters of the structure of the economic environment. For example, if the p^i's are either the growth rates of, or the degree of persistence in surprises in different accounting items, $i = 1, \ldots, N$, then under an accounting treatment that aggregates these items, an inattentive investor may simplify by implicitly assuming that the growth rates or degrees of persistence for all the items are equal, $p^1 = p^2 = \cdots = p^N$. Under disaggregated reporting, the investor may instead extrapolate each item separately. Thus, the framework can capture the effects of aggregation on investor perceptions. More generally, limited attention restricts some parameters to special values,

$$p^i = (p^i)', \quad i = L, L+1, \ldots, N.$$

In sum, allocation timing, aggregation, the format of presentation, and the reporting or disclosure of redundant information can influence the degree to which an investor inattentively simplifies the values of public information signals or the values of environmental parameters. Thus, the expectation formed by inattentive investors is

$$\begin{aligned} S_1^\kappa &= E^\kappa[c_2|\psi; p] \\ &= H(\psi^1, \psi^2, \ldots, \psi^{J-1}, (\psi^J)', (\psi^{J+1})', \ldots, (\psi^K)'; \\ &\quad p^1, p^2, \ldots, p^{L-1}, (p^L)', (p^{L+1})', \ldots, (p^N)'). \end{aligned} \tag{11}$$

Substituting these expectations along with the rational expectations given in (10) into (8) generates the date 1 market price of the security.

This specification of limited attention is general; it describes an approach rather than a refutable hypothesis. The empirical content of the approach derives from specifying the details of the economic environment (as reflected in the H function) and the restrictions that limited attention places upon the ψ^k's and the p^j's.

In the sections that follow we consider three applications as special cases in which parametric restrictions are motivated by the psychology of salience and information processing. We will assume that disclosures that are reported conspicuously in the business press are more salient than those that are reported less conspicuously; that costs that are expensed in financial statements are more salient than costs that are disclosed only in footnotes; and that separate components of earnings are less salient than the overall earnings number. These conditions are reasonable given

psychological evidence of salience effects, and the tendency of individuals to attend less to information that requires greater cognitive processing to be useful.

Some of the empirical predictions we will derive—those describing how managers make disclosure choices—require only that managers believe that investors have limited attention. Such a belief on the part of managers, whether correct or not, is inconsistent with the traditional fully rational approach to modeling disclosure choices. The predictions we derive about stock market behavior, mispricing, and the predictability of abnormal stock returns do require limited investor attention.

4. Pro Forma earnings disclosure

In a time when a disappointing earnings number can cause a company's stock to tumble, more and more companies are focusing on "*pro forma*" earnings to back out some distorting factors. This is supposed to give investors a clearer view of a company's operations, but since there is no regulatory guidance for *pro forma* earnings, companies have increasingly used them to make their earnings look better. An expense may be non-cash or one-time in nature, yet still have significance.

Pro Forma Earnings: Not the Whole Story (Mann, 2001a)

There is substantial evidence that managers use special items in the attempt to manage stock prices and market perceptions of firm performance (see, e.g., Elliott and Hanna, 1996; Kinney and Trezevant, 1997), and that reporting of special items has increased over time (see Collins et al., 1997; Elliott and Hanna, 1996; Bradshaw and Sloan, 2002). A sharply growing practice in recent years has been the disclosure of non-GAAP measures of earnings (often called *pro forma* or street earnings) that exclude certain costs (see Bradshaw and Sloan, 2002). The purported reason for adjustments in *pro forma* earnings disclosures is to reflect special circumstances that are not related to the firm's long-term prospects, such as one-time charges, e.g., non-recurring items restructuring costs, extraordinary items, discontinued operations, or changes in accounting policy (see, e.g., Weil, 2001; Barbash, 2001).

Pro forma earnings often differ substantially from GAAP earnings. For example, The Economist (2002a) discusses a study which asserts that "the companies that make up the Nasdaq 100 index together reported $19.1 billion of profits in pro-forma earnings announcements for the first three quarters of last year. …those same companies reported to the Securities and Exchange Commission (SEC) a total loss for the same period of $82.3 billion," a difference of over $100 billion dollars.

A frequent criticism of *pro forma* earnings disclosures is that many companies fail to state clearly which items are being excluded (see Mann, 2001b), in contrast with the full-disclosure 'unravelling' prediction of the earliest disclosure models (see Grossman, 1981; Milgrom, 1981). Incomplete disclosure may reflect costs of doing so, such as the revelation of information to competitors (see, e.g., the discussion and references in Verrecchia, 2001). However, a fuller GAAP disclosure often follows the

pro forma disclosure within a fairly short period.[13] An alternative possibility is that firms take advantage of a tendency for investors with limited attention to treat *pro forma* earnings as appropriate even when they are not.[14] When firms do reveal GAAP as well as *pro forma* earnings in a single disclosure, firms often place the high *pro forma* earnings numbers conspicuously at the top of their news releases, consistent with exploitation of attentional biases.[15]

We offer a model that reflects both legitimate reasons for reporting *pro forma* earnings, and the possibility of manipulating such disclosure to exploit limited investor or analyst attention. There are three dates, 0, 1, and 2. At the end of date 0, the manager learns what GAAP earnings will be at date 1, and whether there are special circumstances that may make GAAP earnings less relevant for terminal cash flows (as specified below). After learning GAAP earnings, the manager also decides whether to disclose *pro forma* earnings as equal to GAAP earnings, or with an adjustment. Regardless of whether the manager chooses to adjust, investors independently observe the size of the potential adjustment. At date 1, GAAP earnings are reported. At date 2 the final cash flow is realized.

We assume that GAAP earnings ε_1 is a noisy indicator of terminal cash flow. To lay out the effect of limited attention as starkly as possible, we assume that the relation of GAAP earnings to terminal cash flow depends on a state variable that is publicly observable by both manager and investors. Inattentive investors do not pay attention to the state. If the state of the world $\varphi = N$ (Normal), then

$$\varepsilon_1 = c_2 + \delta, \tag{12}$$

where c_2 is the terminal cash flow, δ is random noise that is independent of both the state and c_2, and both variables are normally distributed. In other words, GAAP earnings is an unbiased noisy predictor of the terminal cash flow. There is no information available about δ, so given the information available to investors, in state N, ε_1 is the most accurate possible predictor of the terminal cash flow.

[13] As Mann (2001b) comments, "One of the problems in all of this is the facile nature of financial reporting. Investors want the bottom line, so when a company reports its earnings in *pro forma*, the media is only so happy to oblige. Never mind that the earnings as reported to the SEC come out some 2 weeks later, by that time the headlines have long since passed."

[14] According to The Economist (2002a), "In theory, investors and other users of accounts know perfectly well that pro-forma numbers should be treated with deep scepticism. In practice, pro-forma earnings releases do allow companies to mislead investors: they grab the headlines and since they are the first pieces of information that a share analyst has to talk to traders about, they drive valuations and share prices."

[15] "About 1000 words after reporting its *pro forma* net income of $160 million, for example, JDS Uniphase's latest release on quarterly earnings notes that by 'generally accepted accounting principles,' the company actually lost $1.3 billion," according to Barbash (2001). Limited investor attention seems to be reflected in the form of business communication channels. As stated in the same news story, "Whenever hypothetical numbers appear at the top of a news release, the real numbers should accompany them at the top as well. The first few lines tend to lead the news stories rushed to the public by wire services, which then appear on Internet-based ticker symbol news trackers." Bradshaw and Sloan (2002) report a sharp increase in the discussion of *pro forma* earnings before discussing GAAP earnings in disclosures in recent years.

If the state of the world is $\varphi = \mathrm{E}$ (Exceptional), then GAAP earnings contain the further exogenous independent stochastic noise term a, where $E[a] = 0$, and

$$\varepsilon_1 = c_2 - a + \delta. \tag{13}$$

The realization of a becomes observable to all at the end of date 0. (The analysis would be identical if we were to assume that investors do not observe a until date 1.)

Pro forma earnings can be disclosed either as GAAP earnings, or with an adjustment, purportedly to undo the bias in GAAP earnings, such as the exclusion of an extraordinary item. The effect of excluding the item on *pro forma* earnings is public information, but inattentive investors rely on the firm's disclosure in judging whether such an exclusion is 'appropriate.' Limited attention takes the form of investors failing to discount for the strategic incentive of the firm to manipulate *pro forma* disclosures to improve perceptions of the firm.

Thus, we assume that *pro forma* earnings can be disclosed as either

$$e_1 = \begin{cases} \varepsilon_1, \\ \varepsilon_1 + a. \end{cases} \tag{14}$$

If management adjusts by a as part of his *pro forma* disclosure, management publicly states that it is included, so investors who are attentive can invert and infer GAAP earnings from the *pro forma* earnings disclosure. However, inattentive investors simply treat *pro forma* earnings as if they were adjusted to be maximally informative. Thus, limited attention implies a form of functional fixation.

Our assumption that management can only adjust by an amount a is for simplicity. It reflects sparely the notion that even investors with limited attention are not complete suckers, so that there is some upper bound on their readiness to believe that an excluded cost item is transitory. This bound is likely to depend on the firm's business and circumstances at the time of the disclosure. For example, the firm might have an expenditure associated with a restructuring of the business which could plausibly be presented to investors as being transitory. The potential for excluding such plausibly exceptional expenses is captured in the manager's ability to adjust *pro forma* earnings by a. However, it would be implausible to exclude all of the firm's ordinary wage expenses, so some items are not part of the potential exclusion.[16]

In the exceptional state E, the adjusted *pro forma* earnings are

$$\begin{aligned} e_1 = \varepsilon_1 + a &= (c_2 - a + \delta) + a \\ &= c_2 + \delta. \end{aligned} \tag{15}$$

So if management were to adjust for a in *pro forma* earnings appropriately, i.e., if and only if $\varphi = E$, then *pro forma* earnings would always satisfy $e_1 = c_2 + \delta$—*pro forma* earnings would be an efficient forecaster of future cash flow. Conditional on the normal state, the noise component of *pro forma* earnings as a signal about c_2 is

[16] A more general model would endogenize a by explicitly incorporate reputational costs of making adjustments that have little prima facie plausibility. Although more complex, such a setting would share the basic intuition of our model that managers have an incentive to disclose favorably adjusted *pro forma* earnings in order to exploit limited attention.

identical to the noise component of GAAP earnings, δ. Conditional on the exceptional state, the ex ante noise in adjusted *pro forma* earnings is still δ, whereas the noise in GAAP earnings is $\delta - a$, where δ and a are independent of each other and of the state. It follows that unconditionally GAAP earnings is a white noise garbling of *pro forma* earnings; *pro forma* earnings is a more accurate signal about c_2.

This suggests that adjustments in *pro forma* earnings can help investors with limited attention form more accurate perceptions about the terminal cash flow, consistent with the view of defenders of adjusted *pro forma* disclosures such as Financial Executives International and the National Investor Relations Institute (see Barbash, 2001). However, if a goal of management is to boost the market's short term valuation of the firm, management can opportunistically exploit limited investor attention—either by adjusting for a when doing so is not appropriate (in state N), or by failing to make the adjustment when doing so is appropriate (in state E).

Based on the analysis of Section 3, market weight κ of investors naively assume that the firm will adjust appropriately. These investors believe that *pro forma* earnings are chosen to be maximally informative. The stock price is determined as a weighted average of these inattentive beliefs and fully attentive rational beliefs that condition correctly upon the state of the world.[17]

The manager's objective places weight on two considerations. First is a desire to maintain a high date 1 stock price. The second is a desire to be perceived as behaving appropriately in his decisions as to disclosure of *pro forma* earnings. That is, the manager wants observers to believe that he included the adjustment a if and only if it was appropriate to do so.[18]

Let the manager's action be $\theta =$ Adjust (A) or GAAP (G). Given state φ and potential adjustment value a, the manager's objective trades off the current stock price S_1 against long-term reputation in different states:

$$U(\theta) = \lambda S_1 + \lambda' I^E[\varphi] I^A[\theta] + (1 - I^E[\varphi])(1 - I^A[\theta]), \tag{16}$$

where $\lambda > 0$ and $\lambda' \geqslant 0$ are weights on different components, $I^E(\varphi)$ is an indicator function which is equal to one in the state $\varphi = E$ in which making the adjustment is appropriate and zero otherwise, and $I^A[\theta]$ is an indicator function which is equal to one if the manager chooses the action $\theta = A$, and is equal to zero otherwise. The

[17] Both attentive and inattentive investors think that they can correctly infer $c_2 + \delta$. Thus, for a given market price at date 1, future stock returns from date 1 to date 2 are perceived to be normally distributed, consistent with the mean-variance assumption of Section 3.

[18] The source of the personal benefit to the manager of being perceived (by attentive observers) as making appropriate decisions is outside our model. Managers may simply prefer to behave honestly, or may benefit from acquiring a reputation for honesty. A manager with a reputation for honesty in disclosure may be valuable to firms that wish to commit to investors that disclosures will be accurate. Alternatively, the benefit could be at the firm level, allowing the firm to avoid regulatory action or shareholder litigation. Consistent with such a concern, Mann (2001b) reports that "SEC Chairman Harvey Pitt has in the past few weeks come out and repeatedly warned companies that their dependence upon *pro forma* accounting for their investor communications could get them into trouble with the commission if it is found that the presentation obscures the true results rather than clarifies them. For example, if a *pro forma* statement turns an accounting loss into a profit without clearly explaining how, the SEC may now look at this report as being fraudulent."

parameter coefficient λ measures the weight the manager places upon maintaining a high stock price, λ' is the weight on maintaining a reputation for appropriate behavior in the exceptional state, and coefficient 1 is the weight on maintaining reputation in the normal state. (Since only the ratios of the weights matter for decisions, including a third weight parameter on the Normal state would be redundant.)

Fully attentive individuals update in response to the *pro forma* earnings announcement, knowledge of a, and knowledge of the state, so regardless of whether management makes the adjustment they update based upon the signal $c_2 + \delta$. As is standard in normal learning models, the Bayesian update under normal distributions given a prior mean $\bar{c}_2$ and signal $c_2 + \delta$ is therefore

$$S_1^{\varphi} = (1-\omega)\bar{c}_2 + \omega(c_2 + \delta), \quad \text{where } \omega \equiv \frac{v_\delta}{v_{c_2} + v_\delta}, \tag{17}$$

$v_{c_2} = 1/\sigma_{c_2}^2$ is the precision of the prior cash flow distribution, and $v_\delta = 1/\sigma_\delta^2$ is the precision of δ. Thus, ω is a measure of the informativeness of (properly adjusted) earnings as an indicator of the terminal cash flow.

We will show that in equilibrium management follows a threshold decision rule:

The Threshold Decision Rule. *For a given state φ, include an adjustment a as part of pro forma earnings if and only if $a \geqslant a^{\varphi}$, where a^{φ} is a threshold value, and*

$$a^E \leqslant 0 < a^N, \tag{18}$$

where

$$a^E = -\frac{\lambda'}{\lambda\kappa\omega}, \quad a^N = \frac{1}{\lambda\kappa\omega}. \tag{19}$$

Intuitively, in a given state φ, if the manager adjusts when $a = a_0$, then he even more strongly prefers to adjust for any value $a > a_0$. Doing so this would increase more (or reduce less) the market's valuation of the firm. If the manager has absolutely no concern for accuracy, he will adjust if and only if $a > 0$, so $a^E = a^N = 0$. However, if he places some value on having the firm's adjustment choice viewed as appropriate by attentive investors, he will set $a^N > 0$. In state N, the market valuation benefit of including an adjustment if a is only very slightly positive is outweighed by the personal cost of being known by attentive investors to have made an inappropriate adjustment.

Similarly, in state E he sets $a^E \leqslant 0$. If the state is Exceptional, the market valuation cost of including a very slightly negative value of a in his disclosure *may* be outweighed by the personal cost of being seen by attentive investors to have failed to make a needed adjustment. But a plausible case is $\lambda' = 0$, implying $a^E = 0$, because it is likely that a disclosure that accords with GAAP earnings is a 'safe harbor' that would not harm the manager's or firm's reputation. We now verify the threshold decision rule as equilibrium behavior.

In state N, attentive investors mentally adjust *pro forma* earnings e_1 according to

$$c_2+\delta=\begin{cases} e_1 & \text{if } a<a^N, \\ e_1-a & \text{if } a\geqslant a^N. \end{cases} \tag{20}$$

Similarly, in state E, attentive investors adjust *pro forma* earnings according to

$$c_2+\delta=\begin{cases} e_1+a & \text{if } a<a^E, \\ e_1 & \text{if } a\geqslant a^E. \end{cases} \tag{21}$$

So as in Eq. (10) of Section 3.2, the rational, full-attention valuation $H(\varphi,a,e_1)$ in state N can be expressed in terms of the *pro forma* earnings disclosure as

$$\begin{aligned} H(N,a,e_1;a^N,a^E)&=E^{\rho}[c_2|N,a,e_1;a^N,a^E] \\ &=\begin{cases} (1-\omega)\bar{c}_2+\omega e_1 & \text{if } a<a^N, \\ (1-\omega)\bar{c}_2+\omega(e_1-a) & \text{if } a\geqslant a^N. \end{cases} \end{aligned} \tag{22}$$

Similarly, in state E the full-attention valuation is

$$\begin{aligned} H(E,a,e_1;a^N,a^E)&=E^{\rho}[c_2|E,a,e_1;a^N,a^E] \\ &=\begin{cases} (1-\omega)\bar{c}_2+\omega(e_1+a) & \text{if } a<a^E, \\ (1-\omega)\bar{c}_2+\omega e_1 & \text{if } a\geqslant a^E. \end{cases} \end{aligned} \tag{23}$$

The limited attention valuation treats the *pro forma* earnings disclosure as appropriate. Consistent with the general specification of the effects of limited attention given by Eq. (11), this is equivalent to the individual forming expectations with a simplifying parametric restriction. This is that his expectations satisfy (22) and (23) with incorrect parameter values $a^N=\infty, a^E=-\infty$.

Suppose now that a manager observes state E and potential adjustment value a. If the manager does indeed adjust, as is appropriate, then the limited attention valuation is equal to the full attention valuation as given in (17). The actual stock price is then the weighted average

$$S_1(A)=\kappa S_1^{\rho}+(1-\kappa)S_1^{\rho}=S_1^{\rho}.$$

If the manager does not adjust, then inattentive investors treat GAAP earnings as appropriate and use $e_1=c_2+\delta-a$ instead of $c_2+\delta$ in their Bayesian updating. In consequence, they value the stock as

$$(1-\omega)\bar{c}_2+\omega(c_2+\delta-a)=S_1^{\rho}-\omega a. \tag{24}$$

It follows that the stock price in this situation is the weighted average

$$\begin{aligned} S_1(G)&=\kappa(S_1^{\rho}-\omega a)+(1-\kappa)S_1^{\rho} \\ &=S_1^{\rho}-\omega\kappa a. \end{aligned} \tag{25}$$

This reflects the fact that investors agree on the stock price, except for their differing assessments of the need for an adjustment by a.

By the objective function (16), the manager compares the utility of adjusting, $\lambda S_1^{\rho}+\lambda'$, with the utility of not adjusting, $\lambda(S_1^{\rho}-\kappa\omega a)$. The difference,

$U(A) - U(G) = \lambda' + \lambda\kappa\omega a$, is linearly increasing in a, so for sufficiently high a the manager adjusts, and for sufficiently low a he does not. Equating the two utilities yields the critical value for the exceptional state, $a^E = -\lambda'/\lambda\kappa\omega$, which is negative if $\lambda' > 0$ and is 0 if $\lambda' = 0$. This confirms part of the threshold rule.

Similarly, if the manager observes state N and appropriately does not adjust, then inattentive investors value the stock as S_1^ρ, so the stock price is $S_1(G) = S_1^\rho$. But if the manager does adjust, inattentive investors value the stock based on *pro forma* earnings $c_2 + \delta + a$, so their expectation of the terminal cash flow is

$$(1 - \omega)\bar{c}_2 + \omega(c_2 + \delta + a) = S_1^\rho + \omega a. \tag{26}$$

It follows that the stock price in this situation is the weighted average

$$\begin{aligned} S_1(A) &= \kappa(S_1^\rho + \omega a) + (1 - \kappa)S_1^\rho \\ &= S_1^\rho + \omega\kappa a. \end{aligned} \tag{27}$$

By (16), the manager compares the utility of adjusting, $\lambda(S_1^\rho + \kappa\omega a)$, with the utility of not adjusting, $\lambda S_1^\rho + 1$. The difference, $U(A) - U(G) = \omega\lambda a\kappa - 1$, is linearly increasing in a. So again the manager adjusts if and only if a exceeds a critical value. Equating the two utilities yields the critical value for the normal state, $a^N = 1/\lambda\omega\kappa > 0$. This confirms the remainder of the threshold rule.

This analysis implies both intuitive and surprising comparative statics for the effects of exogenous parameters upon the probability that a biased *pro forma* earnings disclosure will be issued in a normal state. By (19), higher a^N and a^E are associated with a lower probability of an adjusted *pro forma* earnings disclosure. Thus, the comparative statics on a_N and a_E give corresponding implications for probability of adjusted *pro forma* disclosure.

In practice, the safe harbor of GAAP makes it likely that $\lambda' = 0$, $a^E = 0$, so that only upward adjustments occur. Thus, the more interesting comparative statics are for critical value a^N in the normal state. By (19), we have

Proposition 1. *If some investors have limited attention in their evaluation of pro forma earnings announcements, then the probability of an adjusted pro forma earnings disclosure in the N state is increasing in, and in the E state is decreasing in*:

(1) λ, *the managerial preference for a higher current stock price*;
(2) κ, *the weight of inattentive beliefs on the stock price*; *and*
(3) ω, *the signal to noise ratio of properly adjusted earnings.*

When $\lambda' = 0$, $a^E = 0$, *so that only upward adjustments occur, the unconditional probability of an adjusted pro forma earnings disclosure is increasing in* λ, κ, *and* ω.

Intuitively, stronger incentives for managers to manipulate investor perceptions, and more credulous (inattentive) investors increase the likelihood of inappropriate upward *pro forma* disclosure in the normal state. If, as is realistic, GAAP provides a 'safe harbor' for managers ($\lambda' = 0$) so that only upward-adjusted *pro forma* disclosure occurs, then these implications hold unconditionally as well.

If, however, $\lambda' > 0$ so that the firm sometimes is pressured to disclose *pro forma* earnings below GAAP earnings, then stronger incentives to manipulate and greater investor credulity cause a reduction in the amount of pessimistic disclosure in state E.

Most interesting is the comparative statics on ω. It is typically presumed that any effects of investor irrationality will tend to be strongest when investors are poorly informed. Here, higher ω, which by (17) is the signal-to-noise ratio for properly adjusted earnings as an indicator of the firm's true economic condition, implies a *lower* critical value a^N. Thus, more accurate public information is associated with a *higher* probability of upward *pro forma* adjustment. Intuitively, when earnings (*pro forma* or otherwise) are viewed by investors as a stronger indicator of value, there is a stronger incentive for firms to manipulate perceptions of earnings.

We now consider the effect of the threshold rule on bias in *pro forma* earnings and on investor misvaluation. The credulous expectation that inattentive investors form of the future cash flow is equal to *pro forma* earnings, $E_1^{\kappa}[c_2] = e_1$. The actual relation between *pro forma* earnings and cash flow in state N is

$$e_1 = \begin{cases} \varepsilon_1 = c_2 + \delta & \text{if } a < a^N, \\ \varepsilon_1 + a = c_2 + \delta + a & \text{if } a \geqslant a^N, \end{cases} \tag{28}$$

and in state E is

$$e_1 = \begin{cases} \varepsilon_1 = c_2 + \delta - a & \text{if } a < a^E, \\ \varepsilon_1 + a = c_2 + \delta & \text{if } a \geqslant a^E. \end{cases} \tag{29}$$

We now tabulate possible equilibrium stock prices. In state N,

$$S_1 = \begin{cases} S_1^{\rho} & \text{if } a < a^N, \\ S_1^{\rho} + \omega\kappa a & \text{if } a \geqslant a^N. \end{cases} \tag{30}$$

In state E the date 1 stock price is

$$S_1 = \begin{cases} S_1^{\rho} - \omega\kappa a & \text{if } a < a^E, \\ S_1^{\rho} & \text{if } a \geqslant a^E. \end{cases} \tag{31}$$

Since $a^N > 0$ and $a^E \leqslant 0$, a is only added when it is positive, and is only subtracted when it is non-positive. The firm sometimes adjusts upward when doing so is inappropriate, and never adjusts down when doing so would be inappropriate. It follows that $e_1 \geqslant c_2 + \delta$, and $S_1 \geqslant S_1^{\rho}$, where the inequalities are strict for some realizations of the state and value of a. Thus, at the start of date 0 prior to these realizations, $E_0[e_1] > c_2$, and $E_0[S_1] > E_0[S_1^{\rho}]$—market expectations and stock prices are on average upward biased as a consequence of the strategic adjustment of *pro forma* earnings. This proves:

Proposition 2. *If some investors have limited attention in their evaluation of pro forma earnings announcements, then*:

(1) *On average pro forma earnings are higher than GAAP earnings, and are upward biased predictors of terminal cash flow*;

(2) *Average investor expectations of terminal cash flow are upward biased*; *and*
(3) *Stock prices are on average higher than they would be if adjusted pro forma disclosure were prohibited.*

Consistent with Part 1, Bradshaw and Sloan (2002) and Bhattacharya et al. (2003) find a strong bias toward the disclosure of higher *pro forma* earnings than GAAP earnings. In this spirit, Barbash (2001) reports that "Lynn Turner, the SEC's chief accountant, has an acronym for news releases deploying *pro forma* results. He calls them 'EBS releases.' He says that means 'Everything but Bad Stuff.'"

Explicit calculation of the date 0 expectation of the stock price shows how exogenous parameters influence market valuations:

Proposition 3. *The date* 1 *stock price is on average increasing in*:

- *The signal-to-noise ratio of properly adjusted earnings* (ω).
- *The manager's incentive to maintain a high short-term stock price* (λ), *and*
- *Investor inattention* (κ).

Proof. By (30) and (31),

$$E_0[S_1] = E_0[S_1^{\rho}] + Pr(N)\int_{a^N}^{\infty} \omega\kappa a f(a)\,\mathrm{d}a - Pr(E)\int_{-\infty}^{a^E} \omega\kappa a f(a)\,\mathrm{d}a$$

$$= E_0[S_1^{\rho}] + Pr(N)\omega\kappa\int_{\frac{1}{\lambda\omega\kappa}}^{\infty} a f(a)\,\mathrm{d}a - Pr(E)\omega\kappa\int_{-\infty}^{-\frac{\lambda'}{\lambda\omega\kappa}} a f(a)\,\mathrm{d}a. \qquad (32)$$

Differentiating this quantity with respect to ω, κ and λ respectively shows that the expected stock price is increasing in each. □

These findings derive from reinforcing effects. First, taking threshold values as given, an increase in either ω or κ increases the influence of an upward *pro forma* adjustment on price in the N state, as reflected in the $\omega\kappa a$ term in (30); and increases the influences of the failure to make a downward *pro forma* adjustment on price in the E state, as reflected in the $-\omega\kappa a$ term in (31). Second, by Proposition 1, a higher value of either ω, κ, or λ increases the probability of perception-improving upward adjustments (in the N state), and weakly decreases the probability of perception-harming downward adjustments (in the E state, if such adjustments ever occur). Proposition 3 offers several untested implications.

This proposition makes predictions for a general sample of firms that ex ante have a probability of making *pro forma* disclosures. More broadly, the parameters described may have similar implications in settings where the firm may take other kinds of actions to manage investor perceptions. Intuitively, greater inattention κ and higher incentive to boost stock price λ encourages firms to try to manipulate

investor perceptions, and increase firms' success in doing so. Similarly, greater informativeness of earnings ω encourages firms to take steps (such as real investment shifts or earnings management) that make investor perceptions more favorable by increasing earnings.

In empirical tests of this and later propositions, some possible proxies for investor attention or inattention to a firm (κ) may be analyst following, firm size, and the fraction of shares owned by financial institutions. Pressure to maintain a high short-term stock price (λ) can be proxied by variables influencing entrenchment, such as board characteristics, or the presence of corporate control defense mechanisms (such as anti-takeover charter amendments). Possible proxies for the earnings signal-to-noise ratio (ω) may include auditor reputation (size), or earnings response coefficients.

We next consider the relation between excess *pro forma* earnings Δe_1, defined as the differential between *pro forma* earnings and GAAP earnings, $e_1 - \varepsilon_1$, and the amount of misvaluation, ΔS_1, defined as $S_1 - S_1^{\rho}$. We will derive the average relation between these variables in each of the two states, and then unconditionally. First, by (28) and (29), in state φ,

$$\Delta e_1 = \begin{cases} 0 & \text{if } a < a^{\varphi}, \\ a & \text{if } a \geqslant a^{\varphi}. \end{cases} \tag{33}$$

There will be no adjustment in *pro forma* disclosure unless the potential adjustment $a > a^E$. If $a^E < \Delta e_1 < a^N$, then by the threshold rule the state must be E, because in state N such a small adjustment would not be made. Thus, by (31) the average misvaluation conditional on an adjustment occurring and on the size of the potential adjustment a, where $a < a^N$, is

$$E[S_1 - S_1^{\rho} | a, a^E < \Delta e_1 = a < a^N] = 0. \tag{34}$$

If the observed excess *pro forma* earnings is higher, $a^N < \Delta e_1$, then by the threshold rule the adjustment could have occurred in either state. Since *pro forma* disclosure occurs in either state whenever $a > a^N$, the probability of state N conditional on a *pro forma* disclosure with $a^N < \Delta e_1$ is equal to the prior probability $Pr(N)$. However, the adjustment only causes misvaluation in the N state. It follows that

$$\begin{aligned} E[\Delta S_1 | a, a^N < a = \Delta e_1] &= Pr(N)(S_1^{\rho} + \omega\kappa a) + [1 - Pr(N)]S_1^{\rho} - S_1^{\rho} \\ &= Pr(N)\omega\kappa a. \end{aligned} \tag{35}$$

Taken together, (34) and (35) imply a piecewise-linear non-decreasing relation between excess *pro forma* earnings and the size of the misvaluation, with critical threshold a^N (see Fig. 1). Thus, the analysis predicts that the higher are excess *pro forma* earnings, the more negative are the subsequent abnormal returns.

Actual market prices must, in the long run, correct to the rational expectation of the terminal cash flow. So the long-run abnormal return in the model is on average just the negative of the quantities calculated in (34) and (35). Thus, higher excess *pro forma* earnings are associated with more negative average subsequent abnormal returns.

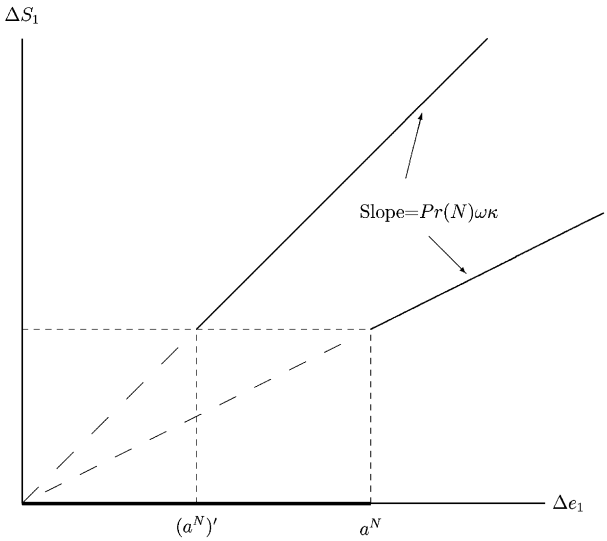

Fig. 1. Misvaluation as a function of excess *pro forma* earnings. Effect of increase in κ, $Pr(N)$, or ω.

Proposition 4. *If some investors have limited attention in their evaluation of pro forma earnings announcements, then the larger are excess pro forma earnings, the greater (more positive) on average is overvaluation, and the more negative is the average subsequent abnormal return.*

Consistent with this prediction, higher excess *pro forma* earnings are associated with more negative subsequent average abnormal returns Doyle et al. (2002). An untested intuitive extension of the long-run returns implication is that the poor subsequent abnormal returns of firms with large excess *pro forma* earnings should tend to be stronger when uncertainty is being resolved, e.g., near the dates of release of subsequent earnings announcements.

Some comparative statics conclusions about the effects of ω, κ, and $Pr(N)$ on the slope of the relationship between misvaluation and Δe_1 follows almost immediately from (34) and (35). Not only does the upward-sloping portion of the piecewise linear relation become steeper as these parameters increase, but (by Proposition 1) the critical threshold at which the positively sloped portion begins, a^N, decreases—to $(a^N)' < a^N$ in Fig. 1. Thus, the average slope $(\Delta S_1/\Delta e_1)$ is uniformly non-decreasing in these parameters, and in some regions is strictly increasing. We summarize these results as follows.

Proposition 5. *The average slope of the relationship between excess pro forma earnings and misvaluation is weakly increasing (with strict inequality for sufficiently large Δe_1) in the fraction of investors who are inattentive (κ), the ex ante probability of the normal state ($Pr(N)$), and the informativeness of earnings (ω). The average slope of the*

relationship between excess pro forma earnings and subsequent abnormal returns is weakly decreasing with these parameters.

The bias in market prices introduced by adjustments in *pro forma* earnings announcements offers a possible motivation for regulation of this practice. Indeed, recently the SEC has pressured firms to reconcile *pro forma* numbers with GAAP numbers conspicuously within *pro forma* disclosures. However, there are also advantages to adjusted *pro forma* disclosure, so the regulatory issues are subtle.

Consider for example the extreme case in which the manager places very high weight on making appropriate *pro forma* reports. In this case he would set $a^E \approx -\infty$, and $a^N \approx \infty$. The accuracy would approach the ideal accuracy, with the signal noise in the earnings disclosure close to its minimum possible value σ_δ^2. The benefit of more accurate market beliefs would then outweigh the very slight upward bias that *pro forma* reporting induces in this case.

Proposition 6. *The pro forma earnings generated by a manager who strategically exploits limited attention in his disclosure policy can be more accurate than GAAP earnings as indicators of firm value.*

Proof. Consider a value of $\lambda > 0$ that is arbitrarily small. Then the managerial disclosure policy is arbitrarily close to the appropriate one (adjust if and only if the state is E). This eliminates virtually all the a noise from GAAP earnings, while the bias becomes arbitrarily small. □

One way to assess whether actual *pro forma* earnings are more accurate than GAAP earnings is to see whether the optimal forecaster of future cash flows is closer to GAAP or to *pro forma* earnings. Consider a regression of future cash flow on *pro forma* earnings, the exclusions in *pro forma* earnings, and other variables (growth and accruals). If the exclusion choice contained no valid information about future cash flow, then GAAP earnings would be the best forecaster, implying that the coefficient on exclusions would be negative and of equal absolute magnitude to the positive coefficient on *pro forma* earnings (thereby offsetting the exclusions component of *pro forma* earnings). In fact, Doyle et al. (2002) find that the coefficient on exclusions, though negative, has magnitude only slightly above $\frac{1}{4}$ of that of the coefficient on *pro forma* earnings. The smaller magnitude of the coefficient indicates that only a small fraction of the exclusions are undone in the optimal forecast, consistent with greater accuracy of *pro forma* earnings than GAAP earnings.

Thus, in this setting *pro forma* adjustments may *help* investors with limited attention analyze the firm appropriately. Even an SEC report warning against abuse of *pro forma* earnings also argued that *pro forma* earnings can "provide a meaningful comparison to results from the same period of prior years," (see Mann, 2001b).

In particular, the incentive to adjust appropriately is decreasing with λ (the weight on the current stock price in the manager's objective). Empirically, this suggests that

pro forma reports will be less accurate for firms that face high pressure to maintain stock prices.

Even though the *pro forma* adjustment induces bias, we further find that inattention can cause investors and analysts to react more strongly to announcements of *pro forma* earnings than to GAAP earnings. This outcome is encouraged when the *pro forma* adjustment reflects incremental information about the error in GAAP earnings as a predictor of future cash flow. To express the idea of reflecting information more precisely, let $w \equiv c_2 + \delta$, be properly adjusted date 1 earnings (the fully attentive expectation of terminal cash flow). GAAP earnings deviate from this by $\varepsilon_1 - w$; the *pro forma* adjustment $\Delta e_1 = e_1 - \varepsilon_1$ reflects information about $\varepsilon_1 - w$ if the adjustment covaries (negatively) with this error.

Proposition 7. *Suppose that excess pro forma earnings reflect information about future earnings, i.e., cov*$(\Delta e_1, \varepsilon_1 - w) < 0$. *Then if inattention is sufficiently severe, stock market prices react more strongly to pro forma earnings than to GAAP earnings.*

The proof is contained in the appendix. Intuitively, this result derives from two sources. First, inattentive investors take *pro forma* earnings at face value rather than properly adjusting earnings. Second, variations in *pro forma* earnings contain corrective adjustments which reduce the sensitivity of price to variations in GAAP earnings.

Consistent with Proposition 7, Brown and Sivakumar (2001), Bradshaw and Sloan (2002), and Bhattacharya et al. (2003) find that stock price reactions to earnings news are more closely linked to *pro forma* earnings than to GAAP earnings in recent years. Lougee and Marquardt (2002) and Johnson and Schwartz (2001) do not find a significant difference in investor reactions to GAAP and *pro forma* earnings; Bhattacharya et al. (2003) attribute these findings to low statistical power owing to smaller sample size.

Also consistent with Proposition 7, Bhattacharya et al. (2003) find that analysts' revisions of one-quarter-ahead earnings forecasts are more closely related to the most recent *pro forma* earnings than GAAP earnings. However, analysts do not place as much weight on *pro forma* earnings as do investors. This suggests that analysts may be more attentive to the strategic motives of management in *pro forma* disclosure than are investors, reflecting their greater expertise.

5. Time allocation: the case of managerial option compensation

> But the newer technologies, and the productivity and bull stock market they have fostered, are also accentuating some accounting difficulties that tend to bias up reported earnings. One is the apparent overestimate of earnings that occurs as a result of the distortion in the accounting for stock options. …not charging their fair value against income, … serves to understate ongoing labor compensation charges against corporate earnings.

Remarks by Federal Reserve Board Chairman Alan Greenspan, "New challenges for monetary policy," August 27, 1999.

Commentators have often alleged that investors pay insufficient attention to unrecognized managerial option compensation of high-tech firms. For example, in discussing the movement by the FASB toward requiring marking-to-market of the cost of employee stock options, a director at PricewaterhouseCoopers, Ohl (2000), observes that "Ironically, information on the 'true cost' of options is already available in the footnotes on employee options that all public companies are required to report. Many users overlook these footnotes or do not regard them as a useful source of information." Many critics have further alleged that such lack of investor attention caused overvaluation of high-tech firms, contributing to the internet boom and crash of the late 1990s (see, e.g., Orr, 2001). These concerns arise because firms are permitted to value employee options when granted at intrinsic value, so that options that are issued with exercise price equal to the current market price are not expensed. The magnitude of the potential effect on earnings of option compensation has been substantial.[19]

It is also striking that the FASB proposal to expense employee stock option compensation failed owing to stormy protests in the 1990s by high-tech firms whose earnings would have been reduced. Dechow et al. (1996) provide evidence that firms that protested the 1993 FASB proposal of expensing of stock options paid higher compensation, used more options in their compensation plans, and used options more intensively for top management relative to other employees. They conclude that the protests were motivated by a desire for managers to hide the costs of the option compensation. According to The Economist (2002b, p. 58), "The FASB had to back away from changing this after intense lobbying by companies, accountants, and politicians. The IASB is currently under similar pressure as it considers the same issue."

Expending resources lobbying to influence regulatory choices among informationally equivalent reporting versus disclosure regimes is puzzling from a fully rational reporting perspective. The structure of compensation contracts can be inferred from information in footnotes and proxy statements. Thus, the opposition by firms to expensing employee option compensation seems to reflect a belief that investors tend to overlook information that is not presented saliently.

In our model, the manager is granted warrants (call options) at date 0 which, if exercised, comprise fraction x of the firm's shares. The options cannot be exercised until terminal date 2. The sum of the exercise prices for all the options is K. Then at date 2 the manager's net option compensation is

$$max[0, x(F + K + \eta) - K], \tag{36}$$

[19] Botosan and Plumlee (2001) report that in a sample of 100 firms identified by *Fortune* as fastest-growing companies, in the 5 years since SFAS 123 stock option expense would have reduced median earnings per share by 14%, and ROA would have been reduced by 13.5%. Furthermore, there was non-compliance by 12% of firms. Their analysis also suggests that the stock option expense was likely to double in the next 5 years. A Merrill Lynch study (reported by Orr, 2001) found that Yahoo!'s 2000 earnings were 1887% higher than it would have been if stock option expense had been included. Out of 37 major high-tech companies, earnings would have been approximately 60% lower than reported if these companies had expensed all stock options given to employees.

where $F+\eta$ is the terminal cash flow of the firm, $E[\eta]=0$, and K is both the cash inflow to the corporation from the manager's option exercise (contained in the expression within the parentheses), and also is the cost to the manager of exercise (the term outside the parentheses). The terminal value obtained by other shareholders is therefore

$$min[F+\eta,(1-x)(F+K+\eta)].$$

To illustrate some simple points minimally, we normalize the exercise price K to zero, so that the options are sure to be exercised. We divide the F component of operating payoff into components publicly resolved at dates 1 and 2, $F=F_1+F_2$, so that the total firm operating payoff is $F_1+F_2+\eta$, where η is independent of F_1 and F_2. Date 1 earnings ε_1 is equal to F_1 as adjusted for any options costs that are expensed.

We allow for persistence in firm cash flows; F_2 is related to the date 1 component by

$$F_2=\gamma F_1+\delta, \tag{37}$$

where δ is white noise. To accommodate firm growth, the F_t's could more broadly be interpreted as deviations from a steady growth trend in cash flows.

In order to focus on the degree of attention directed toward option grants, we assume that all investors are fully attentive to earnings news, so they take into account earnings ε_1. (Similar results apply if this assumption is relaxed.) However, unless there is required reporting of option compensation as a cost, fraction f and market weight κ of investors do not attend at dates 0 or 1 to the stock option grant. Instead, inattentive investors extrapolate date 1 earnings using persistence parameter γ to form their expectation of terminal value per share.[20]

For example, if the options are not expensed at all, then investors with limited attention value current shares as if they could claim the full $F+\eta$. A market weight of $1-\kappa$ is comprised of investors who attend to the fraction x of the future cash flow destined for managers, as in (36) with $K=0$.

Our attentional assumption reflect the psychological fact that individuals focus on salient components of their environment at the expense of information items that are less salient or require additional cognitive processing. We regard earnings, an overall summary measure of performance, as highly salient. Footnote disclosures are less salient in their form of presentation, and require greater cognitive processing in order to generate a modified summary measure of performance.[21]

[20] There is a continuing debate in the empirical literature as to whether investors overextrapolate earnings trends in forming expectations (see Lakonishok et al., 1994; Dechow and Sloan, 1997; Lee and Swaminathan, 2000; Daniel and Titman, 2003; Chan et al., 2003). Our assumption here is orthogonal to this debate. We do not assume that investors overextrapolate recent sequences of earnings (a misestimation of growth rates or persistence), but that they extrapolate from the wrong starting point—a level of earnings that is 'too high.'

[21] The analysis would change if inattentive investors, in ignoring the footnotes, assumed that a given firm possessed the average amount of option compensation that firms have. We think that such a specification of limited attention is not as consistent with psychological evidence as our assumption of simple neglect of the footnoted item, because estimating the average amount of option compensation and

Specifically, we will examine different reporting regimes based on the fraction of the options grant that is expensed at date 1. We define the realized economic cost of the option grant to the firm, ξ as the net cash flow ultimately obtained by management and other employees from their options, i.e., option compensation. Under the amortization regime (A), fraction β of the expected cost is expensed at date 1, $0<\beta<1$, so that earnings are

$$\varepsilon_1 = F_1 - \beta E[\xi|F_1]. \tag{38}$$

In practice, firms are permitted to value employee options using fair values and to amortize the expense over the vesting period. Under the more common intrinsic value method, if the option is issued with exercise price equal to the current market price, the 'intrinsic value' is zero and the option is not expensed at the date of issuance.[22]

We refer to the special case $\beta = 0$ as the *no-expensing regime*, and the special case $\beta = 1$ as the *full expensing regime*. By (36), at date 2 the manager's option compensation is $x(F + \eta)$, since $K = 0$. The expected option compensation cost at date 1 given F_1 is

$$E[\xi|F_1] = (1 + \gamma)xF_1. \tag{39}$$

The rational, full attention stock price at date 1 is therefore

$$S_1^{\rho} = (1 + \gamma)(1 - x)F_1. \tag{40}$$

If inattentive investors wrongly perceive that $\xi \equiv 0$ in (38) and (39), then they interpret high ε_1 as indicating high F_1 and, by (37), high F_2. Thus, limited attention makes these investors credulous in extrapolating from ε_1 to F_2. In contrast, required expensing of option compensation makes its effect more salient.

We now solve for the fully rational stock price in terms of the date 1 earnings using the condition

$$\begin{aligned} S_1^{\rho} &= (1 + \gamma)(1 - x)F_1 \\ &= (1 + \gamma)(1 - x)[\varepsilon_1 + \beta(1 + \gamma)xF_1] \\ &= (1 + \gamma)(1 - x)\left[\varepsilon_1 + \frac{\beta(1 + \gamma)xS_1^{\rho}}{(1 + \gamma)(1 - x)}\right], \end{aligned} \tag{41}$$

where the last equality holds by (40). Solving for S_1^{ρ}, the full-attention valuation can be expressed in terms of date 1 earnings in the form of (10) of

(*footnote continued*)
adjusting for it would be a cognitively *more* demanding task than direct study of the footnote. However, even under this alternative specification, firms with above-average unrecognized option compensation would be overvalued by the market relative to firms with below-average option compensation, consistent with some of our empirical predictions.

[22] We assume that inattentive investors focus on primary earnings per share, not fully diluted earnings per share. Fully diluted earnings are frequently not disclosed at earnings announcement dates. An indication of the salience of primary over fully diluted numbers for investors is that analysts forecast primary, not fully diluted earnings. This may be because fully diluted earnings are based upon economically questionable assumptions about the costs to the firm associated with new equity issuance (e.g., for option compensation, assumptions about the cost of providing shares to the manager).

Section 3.2,

$$H(\varepsilon_1; x, \gamma) = S_1^{\rho} = \left[\frac{(1+\gamma)(1-x)}{1-\beta(1+\gamma)x}\right]\varepsilon_1. \tag{42}$$

Inattentive investors ignore the option obligation, so limited attention imposes the incorrect constraint $x = 0$. Thus, by (38) and (39), at date 1 the firm is valued as

$$\begin{aligned} S_1^{\beta}(A) &= (1-\kappa)S_1^{\rho} + \kappa(1+\gamma)\varepsilon_1 \\ &= (1-\kappa)S_1^{\rho} + \kappa(1+\gamma)[1-\beta x(1+\gamma)]F_1. \end{aligned} \tag{43}$$

We compare this with the limiting endpoints in which $\beta = 0$ or 1.

In the no-expensing (N) regime ($\beta = 0$), the stock price is

$$S_1(N) = (1-\kappa)S_1^{\rho} + \kappa(1+\gamma)F_1. \tag{44}$$

By (40), the misvaluation is

$$\Delta S_1(N) \equiv S_1(N) - S_1^{\rho} = \kappa(1+\gamma)xF_1.$$

In this case, consistent with the critical views of commentators, failure to report option compensation fools investors, so the firm is overvalued by the market. Overvaluation is increasing in the amount of option compensation x, in the persistence of earnings γ, and the fraction of the investors who are inattentive κ.

In the full expensing (E) regime ($\beta = 1$), the firm is valued as the weighted average

$$\begin{aligned} S_1(E) &= (1-\kappa)S_1^{\rho} + \kappa(1+\gamma)\varepsilon_1 \\ &= (1-\kappa)S_1^{\rho} + \kappa(1+\gamma)[1-x(1+\gamma)]F_1, \end{aligned}$$

so by (40), the misvaluation is

$$\Delta S_1(E) \equiv S_1(E) - S_1^{\rho} = -\kappa(1+\gamma)\gamma xF_1.$$

Investors undervalue the firm because the earnings hit is magnified. In effect, it is as if they mistake the date 1 reduction in earnings, which pays for the manager's long-term compensation, as being merely an installment in a continuing stream of compensation.

Undervaluation is increasing in the amount of option compensation x, in the persistence of earnings γ, and in the fraction of the investors who are inattentive κ. Thus, in a full-expensing regime the direction of effect of these parameters is the reverse of that in the no-expensing regime; greater option compensation and greater persistence of earnings are associated with more positive average abnormal returns.

An appropriate choice of the amortization coefficient β can generate a market price at date 1 equal to that under full attention. Equating S_1^{ρ} from (40) with $S_1^{\beta}(A)$ from (43) yields $\beta = 1/1+\gamma$. Thus, if a regulatory goal is to help the market achieve accurate perceptions of the firm's financial condition, there is an optimal expensing policy. Furthermore, this policy depends on the persistence of other components of earnings! This benefit from biasing the expensing of a cost based upon the persistence of other costs contrasts sharply with an approach based upon full attention. These results are summarized as follows.

Proposition 8. *If some investors have limited attention, then*:

(1) *Under a no-expensing (full expensing) regime in which the expected cost of employee option compensation is not expensed (fully expensed) at the time at which the options are granted*:
   - *The market overvalues (undervalues) the firm relative to fundamental value, implying negative (positive) long-run abnormal stock returns.*
   - *Higher employee option compensation is associated with greater overvaluation (undervaluation), and with more negative (positive) subsequent average abnormal returns*;
   - *The greater the persistence of earnings, the greater the overvaluation (undervaluation) associated with a given level of employee option compensation, and the more negative (positive) the average long-run abnormal returns.*

(2) *Under an amortization regime expensing regime in which fraction β of the expected cost of managerial option compensation is expensed at the time at which the options are granted, the market values the firm correctly if $\beta = 1/(1+\gamma)$.*

Consistent with Parts 1 and 2, Garvey and Milbourn (2003) find that the magnitude of unrecognized option compensation is a negative predictor of subsequent abnormal stock returns during 1996–2000. Furthermore, Bell et al. (2002) provide evidence based upon the residual income model suggesting that investors overvalue firms with high levels of employee stock options.

A further intuitive implication is that the correction of mispricing induced by unrecognized option compensation should be particularly strong when more resolution of uncertainty is occurring, such as the dates of release of subsequent financial reports. Garvey and Milbourn confirm that the poor abnormal returns associated with high unrecognized option compensation were concentrated in the months in which quarterly financial reports were released. Similarly, high media publicity to non-expensed option compensation should cause a drop in price of firms that have high option compensation. Some media commentators alleged that increased media publicity about the high levels of option compensation of these companies played a part in the internet stock crash of 2000. Also similarly, a change in regulation that calls investor attention to option costs (such as the introduction by the FASB of required footnoting of option costs) should cause downward revaluation in the stock prices of firms with high option costs relative to those with low option costs.

Garvey and Milbourn also test the further implication of our model that subsequent average abnormal returns are on average more negative when the persistence of earnings is higher. They find that among high-option-cost firms, the differences in mean abnormal returns between firms with high- and low persistence are negative, as predicted, and economically nontrivial. For example, in a subsample of high-dilution firms, they estimate a substantial difference in abnormal returns, close to 6% annually between high- and low-persistence firms. However, the effect of persistence is statistically insignificant. Thus, Garvey and Milbourn conclude that the statistical power of the test does not permit a strong conclusion with regard to this prediction.

Part 1 also explains why firms care about the expensing regime, consistent with firms campaigning politically against required reporting of option expenses (see Dechow et al., 1996). Furthermore, Part 1 suggests that the opposition of firms to full expensing of executive options may have a degree of merit. Under limited attention, just as no-expensing leads to overvaluation, full expensing leads to undervaluation.

The intuition behind the basic point that no-expensing leads to overvaluation and full-expensing to undervaluation seems to extend to a steady-state setting in which a firm has continuing growth, option grants and option exercises. At each date t, investor observation of the actual option exercise clears out past undervaluation (overvaluation), which derived from overextrapolation of the date $t-1$ expensing of (failure to expense) the options. But the issuance of new options generates new undervaluation (overvaluation), so that investor perceptions remain one step behind. This conjectural argument remains to be verified in an explicit model.

It could also be argued that in a dynamic steady state with no expensing (for example), there would not on average be excess stock returns because overvaluation would be continually renewed by the issuance of new options. However, by definition stock returns are the sum of a dividend yield and a capital gains component. Ceteris paribus an elevated stock price reduces the dividend yield component of expected returns, even if overvaluation is continually renewed.

Part 2 implies that the higher is the persistence of earnings γ, the lower the fraction of options costs that would need to be expensed to induce correct market valuation. More generally, in a dynamic setting with positive exercise price the amortization scheme needed to achieve correct valuation would be complex. The robust conclusion here is not that regulation can readily ensure correct valuation, but that the degree of earnings persistence is a relevant consideration for a policymaker who seeks to align market perceptions with firm fundamentals.

Our analysis of executive option compensation has taken firms' option-granting and investment behavior as exogenous. More generally, using an objective similar to that in Section 4, this behavior can be endogenized. In such a setting, requiring the expensing of options would reduce the attractiveness for the firm of option compensation relative to cash or other compensation.[23] Furthermore, if options are not expensed, firms may have an incentive to issue overpriced equity to finance greater investment. This is consistent with the arguments of some high-tech advocates that the expensing of options would lead to a substantial reduction in entrepreneurial activity (see, e.g., Doerr and White, 2002), but does not imply that full expensing leads to lower welfare than a no-expensing regime.

A further conjectural implication is that in a no-expensing regime, firms with high earnings persistence will compensate employees with options (to avoid extrapolation

[23] Such a concern seems to have influenced the decision of CalPERS, the largest pension fund in the U.S., to postpone action on a staff recommendation to require companies to expense employee stock options (see Los Angeles Times, 2002). Indeed, the article attributes to well-known venture capitalist John Doerr the claim that "stock options would disappear as a recruiting tool for start-up firms if their potential value had to be deducted from earnings, reducing companies' reported profit."

of non-option compensation expenses) more than firms with low earnings persistence. In contrast, under full expensing, firms with high persistence will avoid option compensation more (as they are more prone to overextrapolation of option expenses). Thus, the cross-sectional profile of firms that engage in heavy employee stock option compensation is predicted to reverse under proposals to require full expensing such as those recently debated in the U.S. Congress.

The basic intuition provided by the model is not specific to the recognition of option costs. For example, similar reasoning would apply to convertible debt—if the conversion feature is not expensed at issuance, under limited attention the market will overvalue the firm. More generally, any economic costs to the firm that are not currently expensed will contribute to overvaluation, and economic benefits that are not currently recognized will contribute to undervaluation. This suggests a rich possible set of applications for future theoretical and empirical exploration.

6. Aggregation in financial reporting: the case of segment reporting

When attention is limited, the degree to which accounts are aggregated in financial statements matters even if investors possess enough information to disaggregate on their own. GAAP provides for discretion in the way that these aggregates are formed, leading to the possibility of financial reporting management. In the modern age of electronic information technology, it would be feasible to require tremendous amounts of transaction by transaction information to be reported, which would reduce the scope for financial reporting management. However, if attention is limited, it is not obvious whether providing more information allows investors to achieve better outcomes.

To see how reporting aggregation influences investor perceptions, we consider investors who only have a probability of attending to publicly available information about the individual components of aggregate earnings. An individual who (consistent with the psychological evidence discussed earlier) does not process all information and avoids cognitive processing costs is likely to focus on aggregated information, both because of the high salience of the bottom line earnings figure, and because this provides a low-processing-cost overall summary of firm performance. If an individual does not attend separately to each component, he extrapolates aggregate earnings at the average growth rate for aggregate earnings. If he does attend separately, he extrapolates each component at its own growth rate.[24]

We assume that the probability that investors attend to the growth rates of the separate earnings components is higher under disaggregated reporting than under aggregated reporting. Each of the earnings components is publicly available information (e.g., through analyst and news media reports), but the inclusion of this information in financial statements makes it more salient to investors.

[24] This assumption is not based on a general tendency to overextrapolate earnings trends (see the literature discussed in footnote 20). Rather, our focus in on extrapolation based upon an aggregated earnings figure rather than extrapolating rationally based upon disaggregated earnings components.

For concreteness, we consider the issue of aggregated reporting versus segment reporting versus divestiture in a multidivisional firm. Related issues are likely to arise more generally in the aggregation of accounting items, and misattributions investors may make as to the reason for the level of an aggregated item.

Consider a firm that has N segments with different growth rates. The earnings at dates 0, 1, and 2 are:

$$\varepsilon_0 = \sum_{i=1}^{N} u_i, \quad \varepsilon_1 = \sum_{i=1}^{N} u_i g_i, \quad \varepsilon_2 = \sum_{i=1}^{N} (g_i)^2 u_i + \delta_i, \tag{45}$$

where the δ_i's are i.i.d., $E[\delta_i] = 0$ for all i. Here u_i is the date 0 earnings of division i, g_i is the expected growth rate of division i, and the δ_i's reflect uncertainty about segment performance. For simplicity we have made growth at date 1 non-stochastic, though this is not essential. We focus only on firms with positive earnings segments ($u_i > 0$). (In our simple setting, a negative value of earnings at date 0 would extrapolate to negative expected earnings at all remaining dates, in which case the firm should immediately liquidate or otherwise dispose of the segment at date 0.) Finally, we equate earnings with cash flow in this application.

In projecting future earnings the investor or analyst needs to analyze the business for each segment, projecting each at its appropriate rate of growth. A fully attentive investor uses all the u_i's and g_i's to forecast date 2 earnings as

$$E_1^{\rho}[\varepsilon_2] = \sum_{i=1}^{N} (g_i)^2 u_i. \tag{46}$$

Thus, the full-attention valuation can be expressed in the form of (10) of Section 3.2 as $H(u_1, u_2, \ldots, u_N; g_1, g_2, \ldots, g_N)$, where H is the function on the RHS of (46).

Our assumption that average segment growth rates are constant is most applicable to an economy or family of industries which has recently entered a new and sustained phase of higher foreseen earning growth, so that differences in divisional growth rates can persist for relatively long periods before reverting toward zero. Even if all investors are aware of the start of this high-growth phase, we will show that aggregated reporting causes a bias in inattentive forecasts of future earnings growth.

We assume that inattentive investors do not distinguish segments, and therefore extrapolate the firm's earnings at its overall earnings growth rate. This is equivalent to imposing the incorrect restriction on the structural parameters that

$$g_1 = g_2 = \cdots = g_N = \frac{\varepsilon_1}{\varepsilon_0}.$$

Thus, an inattentive investor estimates the growth rate to be

$$r^{\kappa} \equiv \frac{\varepsilon_1}{\varepsilon_0} = \frac{\sum_{i=1}^{N} u_i g_i}{\sum_{i=1}^{N} u_i}, \tag{47}$$

and extrapolates using r^{κ} to forecast date 2 earnings as

$$E_1^{\kappa}[\varepsilon_2] = r^{\kappa}\varepsilon_1 = \frac{(\sum_{i=1}^{N} u_i g_i)^2}{\sum_{i=1}^{N} u_i}. \tag{48}$$

Thus, the inattentive valuation can be expressed in the form of (11) of Section 3.2 as $H(u_1, u_2, \ldots, u_N; g_1, g_2, \ldots, g_N)$, where H is the function on the RHS of (48).

Let S_1^{μ} denote the market valuation of the firm at date 1 under alternative reporting rules $\mu = A$ (aggregated reporting), S (segment reporting), and D (divestiture, i.e., separately traded firms). We assume that date 0 and date 1 earnings are paid out as dividends at date 0 and at the start of date 1 and therefore are not a part of the ex dividend date 1 valuation. Then investors value the firm as

$$\begin{aligned}
S_1^{\mu} &= \kappa^{\mu} E_1^{\kappa}[\varepsilon_2] + (1-\kappa^{\mu}) E_1^{\rho}[\varepsilon_2] \\
&= \kappa^{\mu}\left[\frac{(\sum_{i=1}^{N} u_i g_i)^2}{\sum_{i=1}^{N} u_i}\right] + (1-\kappa^{\mu})\left[\sum_{i=1}^{N} (g_i)^2 u_i\right] \\
&= S_1^{\rho} - \kappa^{\mu}\left\{\frac{[\sum_{i=1}^{N}(g_i)^2 u_i](\sum_{i=1}^{N} u_i) - (\sum_{i=1}^{N} u_i g_i)^2}{\sum_{i=1}^{N} u_i}\right\} \\
&= S_1^{\rho} - \kappa^{\mu}\left\{\frac{\sum_{i=1}^{N}\sum_{j>i}[(g_i)^2 + (g_j)^2]u_i u_j - \sum_{i=1}^{N}\sum_{j>i} 2 g_i g_j u_i u_j}{\sum_{i=1}^{N} u_i}\right\} \\
&= S_1^{\rho} - \kappa^{\mu}\left[\frac{\sum_{i=1}^{N}\sum_{j>i}(g_i - g_j)^2 u_i u_j}{\sum_{i=1}^{N} u_i}\right] \\
&\leqslant S_1^{\rho},
\end{aligned} \tag{49}$$

where the last inequality holds strictly so long as the g_i's are not all equal. It is evident from the last equation that greater inequality of the g_i's tends to reduce S_1^{μ}. For example, a proportional increase in the deviations of the g_i's from their mean ($g_i' \equiv \bar{g} + K(g_i - \bar{g})$, $K > 0$) increases all the $(g_i - g_j)^2$ terms. Similarly, since (for a given sum) products are larger when the components are closer to equal, S_1^{μ} tends to be smaller when the divisions are closer to equal in size (u_i's close to equal).

Thus, so long as the divisions have unequal growth rates, the market value of the firm is lower under aggregate reporting than under segment reporting. High-growth segments are 'hidden-gems' whose high rate of growth are implicitly underestimated. There are also 'skeleton-in-the-closet' segments whose low rates of growth are implicitly overestimated. However, these misjudgments do not, on average, cancel out.

Intuitively, extrapolating the entire firm at its past growth rate ignores the increasing weight in firm value of faster-growing segments over time. Since average segment growth rates are constant, this shift in weight tends to increase the average growth rate of the firm. Thus, under aggregate reporting the stock is undervalued by the market. This analysis suggests that under some circumstances there is merit to

the arguments of analysts who support the divestiture of hidden gems based upon the biblical recommendation "don't hide your light under a bushel."

Under segment reporting ($\mu = S$), a higher fraction of individuals attend to the segments separately, $\kappa^S < \kappa^A$. Eq. (49) holds with $\kappa^\mu = \kappa^S$. Thus, $S_1^S > S_1^A$. After a focusing transaction such as an asset sale, everyone values the segments separately, so each is valued according to its own growth rate, $S_1^D = S_1^\rho$. It follows immediately from (49) as applied to aggregate reporting (κ^A) and to segment reporting (κ^S) that $S_1^D > S_1^S > S_1^A$. We summarize this analysis as follows.

Proposition 9. *In a setting with constant segment growth rates,*

(1) *If not all segments are growing at the same rate, then the market values the firm more highly under segment reporting than under aggregate reporting, and more highly under divestiture than under segment reporting.*
(2) *Holding constant growth rates, the difference in valuation between aggregate reporting, segment reporting and focusing regimes is greatest when divisions are equal in size.*
(3) *Holding constant size, a proportional increase in the dispersion in the growth rates of different divisions increases the difference in valuation between aggregate reporting, segment reporting, and focusing regimes.*

Two immediate empirical implications follow:

Implication. *During periods of high foreseen growth, total firm value on average rises when the firm spins off, carves out or divests a segment.*

Disaggregation encourages the market to weigh rapidly growing segments more heavily, so total firm value increases. This implication is in some ways analogous to the attention hypothesis of Grinblatt et al. (1984), in which stock splits are used by high-value firms to induce investors to analyze the firm. Several papers have found that increased corporate focus achieved through spinoffs, carveouts, and asset sales are associated with upward market revaluations (see Schipper and Smith, 1986; Comment and Jarrell, 1995; Daley et al., 1997). The analysis also predicts a diversification discount in firm valuation during high growth periods. The degree to which the evidence supports a diversification discount is currently under debate (see, e.g., Lang and Stulz, 1994; Berger and Ofek, 1995; Campa and Kedia, 2002; Villalonga, 2001).

Implication. *During periods of high foreseen growth, total firm value on average rises more in focusing transactions if the divested segment's growth rate differs substantially from the growth rates in the remaining firm.*

Daley et al. (1997) report that the abnormal returns associated with announcement of spinoffs are higher when the divested division is in a different industry from the parent firm. In our setting, such cases would on average have higher

announcement returns if divisions in different industries are more likely to have very different growth rates.

The analysis also predicts which divisions will tend to be sold.

Implication. *During periods of high foreseen growth, managers who seek to increase the market valuation of their firm will tend to divest segments (through carveout, spinoff, or sale) whose growth rate differs from the average growth rate of the firm.*

Thus, firms will tend to divest either very slow growth or very high growth divisions.

In contrast with our constant growth assumption, in general segments with unusually high growth rates will tend to revert to a central mean. Such reversion will tend to be more rapid at times when the economy or relevant industries are entering a sustained phase of lower earnings growth. Intuitively, in these circumstances we would expect the relative valuations derived here to be reversed. Individual extrapolation of each segment would place higher weight on recently growing segments, which on average will grow much less rapidly in the future. This implies *lower* future earnings growth than extrapolation of aggregate earnings.

Thus, empirical testing of the segment reporting model requires estimation of start and end dates for phases of high foreseen growth in the economy as a whole, or the set of industries in which the firm has segments. Such dates could be estimated, for example, using long-term real interest rates, macroeconomic forecasts, or stock index prices.

There are of course alternative, agency theories of diversification discount (see, e.g., Lang and Stulz, 1994; Berger and Ofek, 1995). Perhaps, more important than the specific predictions of this application is the illustration of a means of analyzing how aggregation affects investor attention. An interesting direction for future work is to analyze how aggregation choices may cause investors to misattribute shocks between more- versus less-persistent items or segments.

7. Can limited attention affect prices?

Despite the evidence of limited attention effects described in Section 2, on conceptual grounds, some researchers have strong prior beliefs that imperfect rationality cannot affect securities prices. In order to address these priors, we now discuss why limited attention can matter.

It is often suggested that the advice or direct trading of analysts, hedge funds or investment banks will improve arbitrage enough to eliminate any significant mispricing. With regard to direct trading, a literature in behavioral finance and accounting has argued that arbitrage by sophisticated investors (including institutional investors) is limited, so that investor naivete can influence prices (see, e.g., Shleifer and Vishny, 1997; Hirshleifer, 2001; Lee, 2001). With regard to advice, there is evidence that the information provided by stock analysts on the whole increases market efficiency. This evidence suggests that investor attention is directed

more to firms with greater analyst following, and/or that professional analysis tends to guide investor attention effectively. However, there is also evidence that analyst forecasts and recommendations are subject to bias and that these biases are associated with apparent stock market inefficiency; on both aspects of the evidence, see Krische and Lee (2000) and papers cited therein. Despite the obvious potential benefits for investors, there are good reasons to expect intermediaries and advisors to have mixed effects.[25]

Several theoretical papers imply that individuals who irrationally underestimate risk or trade too aggressively can on average earn higher expected profits and/or higher expected utility than fully rational traders.[26] Most of the analyses of survival involve investors who simply misinterpret newly arrived signals, rather than ignoring a strategic feature of the economic environment. Unlike these models, in our paper no investors have superior private information. However, the broad intuition of these studies suggests that limited attention could promote survival (or at least high profitability) if it can promote aggressive trading and high risk bearing. Overconfidence may often be a source of limited attention. Investors who overestimate their understanding of the economic environment may tend to neglect details and engage in shoddy analysis. If attentional failures arise from overconfidence, limited attention may be correlated with aggressive trading and profitability.

Nevertheless, we do *not* rest our argument for modeling limited attention on the questionable claim that individuals who are attending poorly to a relevant issue tend to earn more. Even if individuals with superior attention on average earn more, perfect attention cannot dominate markets, because even the smartest individuals have limited time and attention. As discussed in Section 3, attending carefully to one arena must have an opportunity cost in another arena. There is no presumption that those who happen to allocate more attention to one particular arena survive better in the long run.

It could be argued that wealth will tend flow into the hands of attentional superstars, leading to highly efficient prices. However, this process is likely to be slow

[25] Advisors and intermediaries have incentives to cater to or exploit the irrationalities of potential clients. Thus, intermediaries will only arbitrage away mispricing to the extent that clients who are naive in their own trading are smarter about choosing which intermediaries to trust. Furthermore, even professional financial managers and analysts are subject to limited attention and other cognitive biases, as evidenced by the experimental studies on practitioners discussed in Section 2. Recent high-profile cases of auditor and financial analyst failures to alert investors to corporate reporting problems are also suggestive in this regard.

[26] In DeLong et al. (1991), investors who underestimate risk hold riskier securities, thereby earning higher risk premia. Kyle and Wang (1997), Fischer and Verrecchia (1999), and Verrecchia (2001) find that in imperfectly competitive securities markets, irrationally aggressive trading by informed traders can intimidate rational informed traders, thereby allowing overconfident or aggressive-heuristic traders to earn higher expected utility and profits. However, Verrecchia (2001) finds that when survival depends on the level of expected utility achieved, in an imperfectly competitive securities market, if the market is Bayesian *on average*, then heuristic traders must earn lower expected utility than rational traders. On the other hand, Hirshleifer and Luo (2001) find that even in a competitive securities market, overconfident informed investors can earn higher expected profits than rational informed investors by exploiting superior information more aggressively.

and noisy, as the unpredictable component of asset returns volatility is large. Furthermore, wealth is reshuffled in the process of generational succession, and by the regression phenomenon much of the resources accumulated by sophisticated investors flows to less attentive heirs. Furthermore, in the process of getting rich, individuals may become less rational. This can occur through aging, or as a result of psychological biases in the learning process. In sum, attentional mispricing effects are not ruled out on prior conceptual grounds.

8. Relation to research in behavioral finance

Economists such as Adam Smith, Irving Fisher and John Maynard Keynes argued that imperfect rationality affects investment decisions and market outcomes. However, in subsequent years financial and economic theory moved strongly toward a paradigm of perfect rationality and informationally efficient markets. A critic of economic theory, Simon (1955), emphasized the importance of limits to processing power for economic choices. Behavioral financial economists have long contended that capital market evidence is consistent with imperfectly rational influences on trading, market prices, and the market reaction to new information (see, e.g., DeBondt and Thaler, 1995; Fama, 1998 provides a contrary perspective). In particular, Daniel et al. (2002) argued that limited attention helps explain important aspects of the evidence. Furthermore, Shiller (2000) argued that the U.S. stock market experienced a severe bubble in the late 1990s owing to rising investor attention. He attributed rise investor attention in part to increased publicity about the stock market in the news media and in public discourse.

Recent theoretical research in finance has offered alternative, psychology-based approaches to the modeling of price-setting. Since these approaches differ from the dominant analytical paradigm in financial accounting, the implications for accounting issues are potentially wide-ranging. We describe a subset of models briefly; the survey of Hirshleifer (2001) provides broader coverage. Only a subset of recent psychology-based finance models explicitly consider accounting information, and even those that do so include only a general accounting signal called "earnings." The current paper makes a start at equilibrium analysis of price setting when imperfectly rational investors observe a richer set of financial reporting and disclosure information. But clearly much more remains to be done.

Early theoretical work in behavioral finance used the modeling simplification of mechanistic noise traders to derive implications about excess volatility in security returns, return autocorrelations, and the pricing of closed-end mutual funds (Cutler et al., 1990; DeLong et al., 1990a, b; Frankel and Froot, 1990; Campbell and Kyle, 1993).

A criticism levelled against the noise trader approach is that any pattern of stock return behavior can potentially be explained by an appropriate exogenous assumption about the trading behavior of some set of investors. Indeed, it has been argued that behavioral approaches in general are too protean. In this regard, we agree with the comment of Verrecchia (2001) that "The major difficulty with

substituting some heuristic use of information for Bayes rule is that potentially it explains everything, which, in turn, suggests that it explains nothing.'' However, as emphasized by DeBondt and Thaler (1995), psychology-based models are (or should be) subject to discipline as well: the assumptions about investor biases should be consistent with evidence about how people actually do behave.[27] In this sense psychology-based models can be more disciplined in their choice of assumptions than fully rational ones.

More recent work endogenizes the decisions of irrational traders, and attempts to ground assumptions of investor behavior upon a psychological foundation. One set of recent analytical papers has examined the implications of investor overconfidence for such issues as the determinants of trading volume and excess volatility (Odean, 1998), short-run stock return momentum versus long-run reversal, the tendency for mean long-run abnormal returns subsequent to discretionary corporate events to have the same sign as the average event-date stock price reaction, and the tendency for earnings surprises to predict subsequent abnormal returns (Daniel et al., 1998, 2001). Some work in this genre has assumed that the degree of investor confidence is static, and other work has allowed for biased self-attribution in the learning process (Daniel et al., 1998; Gervais and Odean, 2001) a well-documented bias in which individuals attribute successes to their own qualities and failures to chance, increasing overconfidence.

A model of asset pricing analogous to the Capital Asset Pricing Model can be developed when some or all investors are overconfident about the precision of their private information signals (see Daniel et al., 2001). As a result, a security's expected return is determined by both its risk and by its current level of mispricing. This model has implications for the relative ability of firm size, book/market ratios and other fundamental-adjusted price variables to predict the cross-section of returns in competition with risk measures such as beta, and for the explanatory power of the empirical 3-factor regression model of Fama and French (1996).

The theoretical finance literature on overconfidence does not consider limited attention. However, from a psychological perspective overconfidence may influence the degree of attention devoted to investment decisions. The overconfidence induced by investment success could cause individuals to devote less effort toward, or to be less receptive to useful facts, information, or methods of analysis in subsequent decisions. The finding of Arkes et al. (1986) that experts made less use of useful decision-making tools than non-experts is consistent with this possibility.

Another direction for explaining return autocorrelation patterns has been to combine conservatism (Edwards, 1968), a tendency for individuals under certain circumstances to underreact to new information signals, with representativeness (see, e.g., Tversky and Kahneman, 1974), a tendency for individuals to judge probabilities based on pattern similarity rather than using Bayes rule. In Barberis et al. (1998),

[27] Thus, we are unlikely to attain much out-of-sample predictive power with a made-to-order behavioral story for each capital market pattern to be explained. A more promising procedure is to identify important psychological regularities, and then deduce their implications for a wide range of capital market phenomena.

owing to conservatism investors underreact to a single earnings announcement, but owing to representativeness overreact to sequences of similar announcements.[28] Although their model does not explicitly consider limited attention, the use of the representativeness heuristic to place earnings patterns into categories simplistically (e.g., overextrapolation of trends) instead of performing a careful Bayesian analysis is probably an indirect consequence of limited attention/processing power. More generally, representativeness could lead investors to jump too readily to conclusions as they try to detect patterns in financial ratios indicative of the firm's financial condition.

An alternative possible explanation for stock return momentum and reversal is that investors use different subsets of the information available to them. In Hong and Stein (1999), stock return momentum and reversal results in a setting in which newswatchers condition on information signals but not on market prices, whereas trend chasers condition only on a subset of past prices. Limited attention may offer a possible motivation for their approach.

Loss aversion, a component of prospect theory (Kahneman and Tversky, 1979) is the experimental regularity that individuals display substantial aversion even to very small gambles viewed as increments relative to a salient reference point. This reference point can change across different but logically equivalent descriptions of the decision problem, as well as when the individual faces different decision problems. Such reference-based optimization may be a second-best solution when attention and processing power are limited. Recent work has explored the ability of loss aversion to explain both the equity premium puzzle (Benartzi and Thaler, 1995; Barberis et al., 2001) and the cross-section of stock returns (Barberis and Huang, 2001).

Based upon a survey of empirical evidence in accounting, economics, and finance, Daniel et al. (2002) argue that firms exploit the limited attention of investors in a variety of ways, including: issuing (repurchasing) overvalued (undervalued) equity shares, managing earnings upward prior to the issuance of new equity, guiding analysts' earnings forecasts, and campaigning politically to influence accounting rules. They therefore suggest that limited attention should be considered in setting accounting and regulatory policy. The current paper provides explicit analysis and derives empirical implications related to some of the positive issues raised intuitively by Daniel et al. (2002), as well as other issues.

9. Conclusion

This paper has examined the consequences of limited attention for disclosure, financial reporting policy and market trading. Our approach addresses the issue of why practitioners care about the choice between recognition versus disclosure, and between informationally equivalent forms of disclosure. Owing to limited attention, such choices can affect investor perceptions and market price. In our approach, investors sometimes neglect relevant aspects of the economic environments they face,

[28] Experimental evidence (Bloomfield and Hales, 2002) supports such regime-shifting beliefs, but recent capital market evidence is mixed (Lee and Swaminathan, 2000; Chan et al., 2003).

such as strategic incentives of firms to manipulate investor perceptions. To show the range of applicability of this approach, we analyze the relation of limited attention to *pro forma* disclosure of non-GAAP earnings measures, the effects of expensing employee stock option compensation when granted, and to aggregated versus segment reporting in diversified firms. The analysis helps explain some puzzling stylized facts, and offers several further untested empirical implications.

As an early effort at modeling limited attention in accounting, the analysis is necessarily simplified in many ways. Several limitations of our analysis stand out. First, this paper focuses on the capital market reporting function of financial statements and disclosures, rather than such issues as optimal contracting, performance measurement, taxes, and political constraints (see, e.g., Watts and Zimmerman, 1986; Lambert, 2001). These considerations may affect the conclusions of the analysis. At the same time, incorporating limited attention and processing power explicitly in our models is likely to enrich our understanding of these issues. Such cognitive limitations may help endogenize the common assumption that certain public information signals are non-contractible; that so-called 'rationally ignorant' voters allow political outcomes to be swayed by concentrated interest groups; and that the political process often fixates unduly upon salient items (such as large losses on derivative positions as opposed to the gains being hedged).

Second, limits to attention are exogenous, and we do not explicitly analyze how investors allocate attention. Third, our focus is not primarily on earnings management (though the actions we consider may affect reported earnings), but on choices between seemingly equivalent presentations of information, and on the substantive effects of these choices on investors. Fourth, it would be premature to draw direct policy implications from our approach. Our approach broadly suggests that concerns by regulators about exploitation by firms of investor inattention merit careful consideration. Inattention in our model influences security prices. Since standard theory implies that the cost of capital influences investment decisions, our approach suggests that limited attention may affect resource allocation as well as investor welfare. Our analysis can also serve the modest role of suggesting considerations (such as the possible relevance of earnings persistence for option expensing rules) which might not otherwise come to mind.

Finally, we consider limited attention at a snapshot in time. Eventually, investors should learn at least to some extent from past market errors (such as undervaluing executive option liabilities). Thus, the effects we describe are likely to be strongest at times when fundamentals, reporting behavior, or accounting rules have recently shifted, or when a new crop of investors has recently arrived. To understand these issues more deeply, models are needed of the dynamics of learning and the social process by which the focus of public attention shifts.

Hayek (1945) famously emphasized the role of prices in aggregating the information of individuals to coordinate economic decisions efficiently. However, in a limited attention setting, even when there is no private information, prices may play a meta-informational role of alerting individuals to the implications of those publicly available signals that they are neglecting but that other individuals found useful (see footnote 9). If private information is added to a limited attention setting,

the inefficiency of prices may lessen but not eliminate their effectiveness in conveying private information. Thus, prices may have a dual informational role in coordinating economic decisions.

We close by suggesting several further directions for possible application of a limited attention approach to reporting and disclosure issues.

- *Perceptions of news about earnings and earnings components.* Investors with limited attention may fail to update their beliefs sufficiently in reaction to earnings news, suggesting a possible explanation for post-earnings announcement drift as documented by Bernard and Thomas (1989). Such investors may also attend insufficiently to the implications for future performance of the breakdown of earnings between accruals and cash flows. Our approach therefore suggests a possible explanation for the correlation of accruals with subsequent abnormal stock returns (see, e.g., Sloan, 1996) and indications that firms actively manage earnings to exploit investor misperception of accruals (see, e.g., Teoh et al., 1998a; Xie, 2001). Thus, the limited attention approach suggests a possible unified reconciliation of overreaction to accruals information yet underreaction to earnings (or cash flow) news. We are currently exploring this issue.
- *Off balance sheet liabilities.* Limited attention may help explain why investors are insufficiently skeptical of firms that are positioned to conceal liabilities, such as off-balance sheet contractual provisions.
- *Hedge accounting and fair value accounting.* Limited attention suggests that firms that hedge may be viewed by investors as more risky than those that do not if hedge profits are marked-to-market whereas the long-term business risk the firm is hedging is not marked to market.

Finally, limited attention may help explain, without appealing to political or contracting constraints, certain peculiarities in the structure of accounting rules. In the age of information technology, it has become cheaper to require detailed reporting of numerous transactions (for a given level of resources devoted to auditing). Actual accounting reports differ from such a standard in ways that, from a pure reporting perspective, seem either irrelevant or deleterious. For example, accounting rules permit *aggregation*, which throws away information.

A limited attention approach suggests that even from a pure reporting perspective, aggregation can make sense, because investors may have trouble processing disaggregated information. Similarly, *redundancy* can be helpful when different presentations ease the processing of that information for different uses. An interesting further direction for research will be to explore whether limited attention helps explain the specific structure of financial reporting and regulation.

Appendix A

Proof of Proposition 7. The date 1 stock price is the weighted average of w, the expectation of terminal cash flow formed by attentive investors, and e_1, the

expectation formed by inattentive investors,

$$\begin{aligned} S_1 &= \kappa e_1 + (1-\kappa)w \\ &= w + \kappa(e_1 - w). \end{aligned} \tag{A.1}$$

So letting $V(\cdot)$ denote variance, the covariance of the change in stock price with GAAP earnings ε_1 is

$$\begin{aligned} cov(S_1 - S_0, \varepsilon_1) &= cov(w + \kappa(e_1 - w), w + (\varepsilon_1 - w)) \\ &= V(w) + \kappa\, cov(e_1 - w, \varepsilon_1 - w), \end{aligned} \tag{A.2}$$

since the state, a, and the disclosure decisions under the threshold rule are all independent of w, so that the errors in *pro forma* and GAAP earnings are also independent of w. It follows that the variance of GAAP earnings is

$$\begin{aligned} \text{var}(\varepsilon_1) &= V((\varepsilon_1 - w) + w) \\ &= V(w) + V(\varepsilon_1 - w). \end{aligned} \tag{A.3}$$

So the regression coefficient of the change in stock price (or cash flow expectations) on GAAP earnings is

$$\beta_{\Delta S_1 \varepsilon_1} = \frac{V(w) + \kappa\, cov(e_1 - w, \varepsilon_1 - w)}{V(w) + V(\varepsilon_1 - w)}. \tag{A.4}$$

Similarly, the covariance of the change in stock price with *pro forma* earnings is

$$\begin{aligned} cov(S_1 - S_0, e_1) &= cov(w + \kappa(e_1 - w), w + (e_1 - w)) \\ &= V(w) + \kappa V(e_1 - w), \end{aligned} \tag{A.5}$$

and the variance of *pro forma* earnings is

$$\begin{aligned} V(e_1) &= V((e_1 - w) + w) \\ &= V(w) + V(e_1 - w). \end{aligned} \tag{A.6}$$

So the regression coefficient of the change in stock price (or cash flow expectations) on *pro forma* earnings is

$$\beta_{\Delta S_1 e_1} = \frac{V(w) + \kappa V(e_1 - w)}{V(w) + V(e_1 - w)}. \tag{A.7}$$

Let $\Delta\varepsilon_1 \equiv \varepsilon_1 - w$. Comparing (A.4) with (A.7), we see that $\beta_{S_1 e_1} > \beta_{S_1 \varepsilon_1}$ if and only if

$$\begin{aligned} &\kappa[V(w) + V(e_1 - w)][V(\Delta\varepsilon_1) - cov(e_1 - w, \Delta\varepsilon_1)] \\ &\quad + (1-\kappa)V(w)[V(\Delta\varepsilon_1) - V(e_1 - w)] > 0. \end{aligned} \tag{A.8}$$

But

$$\begin{aligned} cov(e_1 - w, \Delta\varepsilon_1) &= cov(e_1 - \varepsilon_1 + \varepsilon_1 - w, \Delta\varepsilon_1) \\ &= cov(\Delta e_1, \Delta\varepsilon_1) + V(\Delta\varepsilon_1), \end{aligned} \tag{A.9}$$

so $\beta_{S_1 e_1} > \beta_{S_1 \varepsilon_1}$ if and only if

$$-\kappa[V(w) + V(e_1 - w)]\, cov(\Delta e_1, \Delta \varepsilon_1) + (1-\kappa)V(w)[V(\Delta \varepsilon_1) - V(e_1 - w)] > 0. \quad \text{(A.10)}$$

If $\kappa \approx 1$, this condition reduces to $cov(\Delta e_1, \Delta \varepsilon_1) < 0$. □

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