CEO Turnover and Properties of Accounting Information*

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Abstract

Multiple-performance-measure agency models predict that optimal contracts should place greater reliance on performance measures that are more precise and more sensitive to the agent’s effort. We apply these predictions to CEO retention decisions. First, we develop an agency model to motivate proxies for signal and noise in firm-level performance measures. We then document that accounting information appears to receive greater weight in turnover decisions when accounting-based measures are more precise and more sensitive. We also present evidence suggesting that market-based performance measures receive less weight in turnover decisions when accounting-based measures are more sensitive or market returns are more variable.

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1 Introduction

One of the primary contributions of agency theory has been to identify what properties make for a good measure of an agent’s performance. Multiple-performance-measure agency models such as Banker and Datar (1989) and Holmstrom and Milgrom (1991) indicate that use of performance measures that are relatively more precise and more sensitive to the agent’s effort can help mitigate agency costs. This research has spawned a growing empirical literature attempting to assess whether firms’ corporate governance practices conform to these predictions. Lambert and Larcker (1987) and Bushman, Indjejikian and Smith (1996), for example, focus on boards’ choices over annual compensation grants, and show that contracts substitute toward market- and accounting-based measures when such measures are better indicators of managerial performance. Other research addresses general governance structures and policies. For example, Bushman, Chen, Engel and Smith (2003) document that the structure of incentives provided to firms’ boards of directors and the extent of ownership concentration vary in systematic ways with properties of managerial performance measures.

Our objective in this paper is to study how the relation between various performance measures and CEO turnover is affected by properties of the firm’s accounting system. Specifically, we examine cross-sectional variation in the weights placed on accounting and market return information in CEO turnover decisions, and relate this to properties of these performance measures. Many studies (beginning with Coughlan and Schmidt (1985), Warner, Watts and Wruck (1988), and Weisbach (1988)) have analyzed CEO turnover, and the development of this literature largely parallels that on CEO compensation. To date, however, fewer studies have attempted to explain across-firm variation in the association of accounting- and market-based performance measures with executives’ continued employment. One exception is Defond and Park (1999), which shows that industry-adjusted earnings factor more strongly into turnover decisions for firms in less concentrated industries.  

While boards’ compensation decisions have received considerable attention in academic literature on the use of performance measures, we offer three reasons why CEO turnover decisions

\[\text{1}\] There is a substantial literature on the relation between analyst forecast errors and the likelihood of CEO turnover. Puffer and Weintrop (1991) and Farrell and Whidbee (2002), for example, argue that the deviation of realized earnings from expected earnings may provide additional information about how CEO performance deviates from board expectations. While Farrell and Whidbee (2002) examine whether the properties of analyst forecasts (i.e., forecast dispersion) affect their weight in the turnover decision, this literature does not explore cross-sectional variation in the properties of firms’ accounting systems, which is our main aim.
might yield greater insights into how information is used in corporate board rooms. First, it is well documented (see Hall and Liebman (1998) and Murphy (2000a)) that most firm-related variation in top executive wealth stems from changes in the value of executives’ stock and option holdings. This raises the question of the extent to which annual compensation decisions have significant effects on executives’ actions, and thus significant effects on firm value. However, while boards may (at least partially) delegate compensation decisions to capital markets through the use of equity-based instruments, boards cannot delegate authority over continued employment of CEOs. In considering retention decisions, directors may of course make use of market- and accounting-based performance measures, but the directors themselves must make the decision about retaining the CEO.

Second, prior research (see Weisbach (1988) and Murphy and Zimmerman (1993)) provides ample evidence that earnings are a significant predictor of CEO turnover. Hermalin and Weisbach (1998) offer a possible explanation for this fact by pointing out that share prices reflect the market’s expectations regarding the CEO’s continued employment. This effect partially confounds the link between market returns and CEO turnover, meaning boards may have to rely more heavily on accounting-based measures in making CEO retention decisions. Given this, it is important to gain an understanding of the properties that affect accounting information’s usefulness in such decisions.

Third, boards’ turnover decisions likely reflect a broader set of concerns than compensation decisions. While turnover can be used as an incentive mechanism, matching considerations likely figure prominently as well. As Baker, Jensen and Murphy (1988) note, incentives are determined by the slope of the relation between pay and performance; thus, if the likelihood of termination is higher when performance is worse, then the threat of firing can provide incentives. However, CEO turnover can also be driven by the board’s conclusion that the CEO’s ability is low, or that the CEO’s skills are not well matched to the firm’s needs. If turnover decisions primarily reflect incentive considerations, then the board uses firm-level performance measures to make inferences regarding the CEO’s effort. If, on the other hand, turnover decisions reflect ability or matching considerations, then the board uses firm-level measures to make inferences regarding ability or the suitability of the match. These two cases each suggest a similar pattern in the association between properties of firm performance measures and CEO turnover.

Note that this question leaves open the issue of why, given the high opportunity costs of members’ time, boards would bother going through the exercise of annual performance reviews and compensation grants if there is no effect on executives’ actions.
In this paper, we examine how the weights on accounting- and market-based performance measures in CEO turnover decisions are related to their properties as measures of managerial performance. In particular, we expect that when accounting is more informative about managerial performance, boards of directors should rely more heavily on accounting returns in making decisions about continuation of CEO employment. Hence, turnover probability should rise faster with reductions in accounting returns in firms where accounting information is a better measure of managerial performance. We also consider how the weight on market-based measures is affected by the properties of both accounting- and market-based measures.

To test these predictions, we devise measures of the signal and noise contained in accounting- and market-based measures of managerial performance. Following prior work (see, for example, Lambert and Larcker (1987) and Bushman et al. (1996)), we capture “noise” by computing the historical variance of accounting- and market-based measures of performance. To devise a measure of signal in accounting-based measures, we apply recent research by Ball, Kothari and Robin (2000) and Bushman et al. (2003), among others, in devising a measure of earnings “timeliness.” This measure is intended to reflect the extent to which current earnings capture current value-relevant information. The underlying intuition for the use of this measure is that the more timely earnings are in capturing value-relevant information, the greater weight investors and directors place on them in assessing how and why equity values are changing. In an appendix, we analyze a simple principal/agent model and develop conditions under which the weight on earnings in an agency relationship increases with earnings timeliness. To measure timeliness, we rely on measures of the association between earnings and contemporaneous stock returns. Our model shows that the association between earnings and returns is increasing in timeliness, but is also affected by the variances of the accounting- and market-based measures. Hence, by holding these variances fixed, we can use this association as a measure of earnings timeliness. We control for these variances in several ways, as we discuss below.

We use our signal and noise proxies to examine variation in the extent to which these measures play a role in CEO retention decisions for a sample of 1,293 CEO turnover events identified using Forbes annual executive compensation surveys between 1975 and 2000. Taking the standard logit regression of CEO turnover on firm performance as a starting point, we interact accounting- and market-based measures of firm performance with our signal and noise proxies. We find support for the notion that our noise and timeliness measures affect the

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3Specifically, we compute the $R^2$ from a reverse regression of earnings on contemporaneous returns.
weight on earnings information in turnover decisions. Our results suggest that, *ceteris paribus*, the weight on earnings information is increasing in earnings timeliness and decreasing in the variance of earnings. Our estimates of these effects are statistically significant at between the one and five percent levels.

We also test a prediction from our model that firms rely less heavily on market-based measures when accounting information is more timely or when market returns are noisier. Our results here depend on the sample we analyze. Using a sample of CEO turnovers that press accounts characterize as “forced departures,” we find the weight placed on market returns in turnover decisions is decreasing in earnings timeliness and in the variance of returns. Using a broader sample of all CEO turnovers (which presumably includes many cases where CEOs simply retire), we do not find support for this hypothesis.\(^4\)

Finally, we incorporate the results of Defond and Park’s (1999) analysis into our tests. They find that measures of industry concentration can explain across-firm variation in the use of industry-adjusted accounting measures in turnover decisions. Given that both their study and ours address variation in the weight on accounting information in turnover, we are interested in examining the relation between the two sets of findings. It is possible, for example, that industry concentration is the key driver of both sets of findings, and that our proxies for signal and noise in earnings information are simply reflecting this fact. To examine links between the analyses, we construct measures of industry concentration and interact them with firm performance measures in our CEO turnover regressions. We find that both properties of accounting information and industry concentration help explain cross-sectional variation in the use of accounting-based performance measures in CEO turnover, and including concentration measures does little to alter our main findings.

The remainder of the paper proceeds as follows: In section 2, we develop our proxies for signal and noise and provide intuition for our model. In section 3, we describe our data and sample selection procedures. In section 4, we describe our analysis and present results. Concluding comments are contained in section 5. The model appears in the appendix.

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\(^4\)As we discuss below, classification of turnovers as “forced” or “non-forced” must be taken with the usual caveat regarding use of press accounts in researching CEO turnover; as Warner et al. (1988) (and others) have pointed out, firms may elect to characterize turnover as non-forced even when poor performance is a key driver of turnover. For this reason, we run our tests on the broad sample of turnovers in addition to the subsample classified as “forced.” We include two age-related variables, age and a dummy for whether the CEO is at retirement age, in the regressions to help control for legitimate retirements in the broader sample.
2 Measures of Signal and Noise

Our primary objective is to explain the cross-sectional variation in the weights placed on accounting and market return information in boards’ CEO retention decisions. In this section, we consider boards’ objectives in making CEO retention decisions, and create proxies for the signal and noise in measures of managerial performance.

Prior research suggests that turnover decisions can be affected by both incentive and matching considerations. If the probability of CEO turnover increases when firm performance worsens, then the threat of firing can serve as an incentive mechanism. For example, in their study of CEO incentives, Jensen and Murphy (1990) explicitly incorporate the lost wages associated with being fired into their calculation of how CEO wealth varies with changes in shareholder wealth. CEO turnover is also likely to be driven by matching considerations; boards are more likely to fire the CEO if they determine his ability is low, or if his skills are poorly matched to the firm’s needs (see Hermelin and Weisbach (1998)). In either case, a key role of accounting- and market-based performance measures is to allow the board to make inferences regarding the manager’s actions or ability.

A large literature examines the question of what makes a measure useful for evaluating a manager’s actions or ability. The broad conclusion of this research is that the usefulness of a performance measure is related to the extent to which it contains precise information about the CEO’s actions. That is, a performance measure with a greater precision and sensitivity (i.e., a higher signal-to-noise ratio) will receive greater weight in decisions. This assertion arises from a variety of agency models (see, for example, Holmstrom (1979) or Banker and Datar (1989)).

We note that the agency literature and empirical tests of agency models typically focus on providing incentives in a contracting setting. We argue that if the threat of termination is used to provide incentives, then factors affecting weights on performance measures in compensation contracts ought to be determinants of their weights in making CEO retention decisions.

A key challenge for empirical researchers, therefore, is to devise measures of signal and noise in observed performance measures. Historical variances of market- and accounting-based performance measures are straightforward measures of noise. As a measure of signal, we argue that earnings “timeliness” is related to the strength of the signal about managerial actions.

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5 As noted by Lambert (2001) and others, historical variances are not ideal as a measure of noise. The theory speaks to the variance of the measure conditional on the manager’s action, while we (and other researchers) can measure only the unconditional variance.
contained in earnings.

Our argument here is that current earnings will be more useful in assessing performance when earnings reflect managerial actions more immediately. As an illustration, consider a firm that makes significant investments in research and development (R&D) activities. Under generally accepted accounting principles (GAAP), this firm is required to recognize R&D outlays as expenses in the period in which they occur, but the accounting recognition of related benefits likely occurs in the future. While these benefits would be reflected in market value immediately, this firm would display low earnings timeliness. For such a firm, an earnings decrease coming from such investments is likely not indicative of poor managerial performance. Earnings, in this case, offer a weak signal of current managerial actions. In contrast, consider a firm where the full effect of a manager’s decisions and actions on firm value are reflected in earnings right away. Here, earnings offer a strong signal of current managerial actions.

To capture earnings timeliness, we rely on a measure of the association between earnings and changes in firm market value. We develop a model to study conditions under which a higher association between earnings and returns implies greater weight on earnings in managerial incentive arrangements. As we discuss in more detail below, this association has been used as a measure of the quality of earnings as a performance measure in a number of empirical studies. Despite this prior work, however, to our knowledge no existing multiple-performance-measure agency model provides predictions about how this earnings/return association affects the weight on earnings in incentive contracts. We present our model in the appendix, and discuss the intuition for those results here.

Our model has three key features. First, the firm’s market value is the sum of book value and the market’s expectations of current and future earnings, consistent with Ohlson (1995). Second, current managerial effort translates noisily into value creation, but only a fraction $\gamma$ (which we refer to as the firm’s “timeliness parameter”) of current value creation appears in current earnings, with the remainder appearing in future earnings. Since the market incorpo-

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6We use the terms “return” and “change in market value” interchangeably in this discussion.

7Bushman, Engel and Smith (2002) study conditions under which a greater association between earnings and returns leads to a greater weight on earnings, when earnings are the only performance measure in the contract. They do not consider the case where the firm can also contract directly on changes in market value. Also, while our model focuses on the use of accounting- and market-based performance measures for the purpose of providing incentives, similar insights can be gained for the case where matching drives turnover, as we discuss in the appendix.
rates information about future earnings into current prices, however, all current value creation is reflected in current changes in market value. Third, changes in market value reflect not just current value creation, but also changes in expectations regarding future value creation. These changes in expectations regarding future value creation are distinct from current value creation and therefore are not useful in assessing current managerial performance. A similar notion is found in Hermalin and Weisbach (1998), who note that while earnings are a function of current management only, stock returns also reflect the market’s expectations of future management changes.

Under these assumptions, earnings and returns each have different potential weaknesses as measures of managerial performance. If earnings are not timely (low $\gamma$), then current earnings are affected more by past events than by current managerial actions. This means the signal of current managerial actions in current earnings is weak. Change in market value reflects both the current value creation and changes in expectations regarding the firm’s ability to create value in the future. While the signal in returns is strong, it is noisy due to the changes in expectations regarding future value creation.

To summarize, the advantage of change in market value as a performance measure is that it reflects all of the manager’s current value creation. The advantage of earnings as a performance measure is that it does not reflect random changes in expectations regarding future value creation. That is, earnings are a precise measure of part of the current value creation, while returns are a noisy measure of all current value creation. Given this, it is clear why increases in the timeliness parameter $\gamma$ lead to increases in the weight on earnings and decreases in the weight on change in market value. An increase in $\gamma$ strengthens the signal in earnings without changing any other properties of the measures. The new optimal contract features a higher weight on earnings and a lower weight on change in market value.

Note that the association between earnings and changes in market value is positively related to the timeliness parameter $\gamma$. An increase in $\gamma$ therefore leads to both an increase in the association between earnings and changes in market value and an increase (decrease) in the weight on earnings (change in market value) in an optimal contract. Does this imply that the weight

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8We make a distinction between current value creation that is realized in the future and future value creation. Managers may take actions today that lead to future increases in earnings; we refer to this as “current” value creation. By “future” value creation, we mean value creation that is unrelated to current managerial actions or ability. As an example, if a manager works today to discover and invest in a positive net present value project, then we would refer to this as current value creation even if earnings are not affected in this period.
on earnings in an optimal contract is positively related to the association between earnings and changes in market value? Not necessarily, since this association is also affected by the variances of the two measures. If, for example, the variance of returns increases, then the association between earnings and returns will fall, but the weight on earnings may increase. Similarly, if the variance of earnings falls, then the association between the two measures increases. This will lead to an increase in the weight on earnings, but this arises because of a reduction in noise, not an increase in timeliness (that is, signal). Hence, we would ideally like to compare two firms with identical variances of earnings and returns, but different associations between earnings and returns. We use regression analysis to perform the necessary \textit{ceteris paribus} calculation. In our empirical models, we control for these variances in several ways, as we discuss in greater detail below.

As mentioned above, the association between earnings and returns has been used in much prior work on properties of earnings as a managerial performance measure. However, as Sloan (1993) has previously noted, there is little consensus in the literature as to how this association should be related to the weight on earnings. Bushman et al. (1996) and Bushman et al. (2003), for example, argue that a high correlation between earnings and returns is indicative of high quality earnings that reflect CEO actions well. Lambert and Larcker (1987) and Ittner, Larcker and Rajan (1997) propose the opposite relation, arguing that earnings that are not informative about firm value can still provide valuable information for evaluating the CEO. Our model rationalizes these opposing viewpoints, by incorporating both and offering conditions under which each holds.\footnote{Our argument is related to, but distinct from, that of Sloan (1993) (see pages 88-89), who focuses on the ability of earnings to shield executives from market-wide movements in stock prices. Our analysis is closer in spirit to Barclay, Gode and Kothari (2000), who also assume that stock price reflects both current and anticipated earnings and examine the implications of timing differences in earnings and returns.}

Specifically, reductions in the earnings/return association make earnings \textit{more} useful as a performance measure if the reduced association is driven by increased variation in returns that is unrelated to current value creation.\footnote{A common intuition for the Lambert and Larcker (1987) and Ittner et al. (1997) view is that if earnings contain “different” information from returns, then earnings are a more valuable signal of managerial performance. The validity of this intuition can be seen here; if changes in market value are increasingly due to changes in the market’s expectations regarding future value creation, then the “different information” contained in earnings must be information regarding current value creation.} Reductions in the earnings/return association make earnings \textit{less} useful as a performance measure if the reduction is driven by a decrease in the fraction of current value creation that appears in current earnings. This
reasoning immediately suggests that holding the variances of the earnings and returns constant, reductions in the earnings/return association make earnings less useful as a measure of managerial performance, which is our hypothesis.

In our empirical analyses, we follow Bushman et al. (2003) and use an earnings timeliness measure developed by Ball et al. (2000) to capture the earnings/change-in-market-value association. These papers define earnings timeliness as the extent to which current earnings incorporate current economic income or value-relevant information, and construct the measure by assessing the time-series relation between earnings and returns. Under GAAP, earnings timeliness may differ across firms for a variety of reasons. Differences in accounting conservatism, the extent of growth opportunities, the extent of delayed recognition of holding gains, and the effectiveness with which expenses are matched with associated revenues (particularly relating to intangible assets) can all drive differences in timeliness.

We compute the timeliness measure as the $R^2$ from a firm-specific reverse regression of annual earnings on contemporaneous stock returns (see Basu (1997)). In operationalizing this proxy, we use a reverse regression rather than the traditional returns-on-earnings regression. This specification avoids potential specification problems arising from the use of a noisy earnings measure as an independent variable. Further, the reverse regression allows us to treat negative returns differently from positive returns. Our regression equation is

$$EARN_t = a_0 + a_1 \text{NEG}_t + b_1 \text{RET}_t + b_2 \text{NEG}_t \times \text{RET}_t + e_t.$$  \hspace{1cm} (1)

We compute $EARN_t$ as earnings before extraordinary items, discontinued items and special items (i.e., “core” earnings) in year $t$ deflated by the beginning of year market value of equity. $\text{RET}_t$ is the 15-month stock return ending three months after the end of fiscal year $t$. $\text{NEG}_t$ is a dummy variable equal to 1 if $\text{RET}_t$ is negative, and 0 otherwise. We estimate this model for the most recent ten-year period for each sample firm-year, provided data from at least eight of the ten years is available.

We use the $R^2$ from the regression in equation (1) to measure the association between earnings and stock returns.\(^\text{11}\) As our model suggests, after controlling for the variances of earnings and returns, we expect this proxy to capture the signal in accounting earnings. Thus,

\(^\text{11}\)Note that $R^2$ from this regression can vary from zero to one. The case where $R^2 = 0$ corresponds to the case where $\gamma = 0$, and which implies that current earnings are of no value in assessing managerial performance. The case where $R^2 = 1$ corresponds to the case where current earnings reflect only current value creation (that is, $\gamma = 1$) and the only factor affecting market returns is current managerial value creation (that is, no noise). If $R^2 = 1$, then earnings and returns are completely equivalent as measures of managerial performance. For the
our first hypothesis is that in a cross-sectional regression of CEO turnover on firm performance variables and variances, the magnitude of the coefficient on earnings should be an increasing function of ER_RSQ, our measure of the $R^2$ from equation (1). Further, we expect the magnitude of the coefficient on market returns should be a decreasing function of ER_RSQ.

In addition to our proxy for signal, we create proxies for the noise in our performance measures. As noted earlier, the variance of a performance measure is a fairly straightforward measure of its noise. Our model provides support for this notion and demonstrates that the weight on earnings in an incentive contract is decreasing in the variance of earnings. Further, controlling for the variance of earnings, the weight on returns is decreasing in the variance of returns. Note that our variance measures are playing two key roles in the analysis. First, as discussed here, these measures allow us to test hypotheses relating to how the noise in a measure affects its use. Second, we argued above that it is important to hold the variances of accounting- and market-based measures fixed when using the association between earnings and changes in market value as a measure of timeliness. Including variance measures into our empirical analysis helps us achieve both aims.

As our measure of the variance of earnings (EarnVar), we compute the variance of industry-adjusted core earnings. We use earnings information for the most recent ten-year period for each sample firm-year, provided data from at least five of the ten years is available. Industry adjustments are computed using Compustat firms as a comparison group, defining industry based on two-digit SIC industry codes. In cases where there are fewer than five firms in a two-digit industry, we use one-digit industry adjustments. We measure return variance (RetVar) similarly, computing the variance of industry-adjusted monthly stock returns and using CRSP firms in the same two-digit SIC code as our comparison group. We include both variance measures in our analysis and hypothesize the following: in a cross-sectional regression of CEO turnover on firm performance variables, the magnitude of the coefficient on each performance

more realistic case of $0 < R^2 < 1$, the degree of association between earnings and returns will be determined by both $\gamma$ and the variance terms.

12 We conduct a Fisher transformation of the $R^2$ from equation (1) in computing our proxy, ER_RSQ, to obtain a more normally distributed variable for use in our estimations. The Fisher transformation $z$ is computed as follows: $z = .5 \log(\frac{1+x}{1-x})$, where $x$ is the $R^2$ from equation (1). The transformation does not qualitatively change the reported results.

13 We discuss in section 4 the use of industry-adjusted performance information in the context of assessing CEO turnover activity.
measure will be decreasing in the variance of that measure. In addition, for comparability with prior work, we conduct tests using a relative noise variable similar to that in Lambert and Larcker (1987). It is straightforward to show that our model’s results are consistent with Banker and Datar (1989) and Lambert and Larcker (1987), with the ratio of weights in the incentive contract proportional to the signal-to-noise ratios. We define VarRatio to be the ratio of EarnVar to RetVar. As in Lambert and Larcker (1987), we expect higher values of this ratio to be associated with greater noise in accounting earnings relative to stock returns. We hypothesize that the magnitude of the coefficient on earnings should be a decreasing function of VarRatio. Further, the magnitude of the coefficient on market returns should be an increasing function of VarRatio.

3 Sample selection

As in Murphy and Zimmerman (1993), we identify our sample of CEO turnovers using the Forbes annual compensation surveys. These surveys list identities, ages, and compensation amounts for CEOs of 800 large US firms. Our survey data cover the time period from 1975 to 2000. We begin by examining the Forbes data to find cases where either the CEO is listed as being in year zero or year one of his CEO tenure, or the CEO listed in the sample has changed from one year to the next. After identifying an initial list of CEO turnovers, we use Lexis-Nexis and Dow Jones News Retrieval to search for articles or press releases that will allow us to determine the reason for each turnover. We restrict attention to sample firms for which we had no missing years during which the CEO changed. (For example, the firm is excluded if we had CEO information for 1975-1978 and 1984-1987, and the CEO changed between 1978 and 1984.) For firms where Forbes was missing three or fewer intermediate years and the CEO changed, we collected missing CEO data from firm’s proxy statements.

We identify 1,813 turnovers over the 1975-2000 period. Inability to match the firms to CRSP or Compustat identifiers reduces the sample to 1,806 turnovers. Missing age data reduces the sample to 1,801, and missing annual earnings or returns data reduces the sample to 1,596. Finally, the time series requirements for calculating the relative noise and timeliness metrics reduce our sample of turnovers to 1,330. These data requirements induce the usual survivorship bias.

Table 1 lists the reasons for the turnovers in our sample. We attempt to classify the turnovers according to whether the articles suggest the CEO was forced to leave his position. We
Table 1: Reasons for Turnover

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retirement</td>
<td>851</td>
<td>63.98</td>
</tr>
<tr>
<td>Health</td>
<td>27</td>
<td>2.03</td>
</tr>
<tr>
<td>Assume another position within firm</td>
<td>165</td>
<td>12.41</td>
</tr>
<tr>
<td>Death</td>
<td>37</td>
<td>2.78</td>
</tr>
<tr>
<td>No article</td>
<td>79</td>
<td>5.94</td>
</tr>
<tr>
<td><strong>Non-forced</strong></td>
<td><strong>1,159</strong></td>
<td><strong>87.14</strong></td>
</tr>
<tr>
<td>Fired</td>
<td>29</td>
<td>2.18</td>
</tr>
<tr>
<td>Poor performance</td>
<td>49</td>
<td>3.68</td>
</tr>
<tr>
<td>Pursue other interests</td>
<td>16</td>
<td>1.20</td>
</tr>
<tr>
<td>Policy difference</td>
<td>17</td>
<td>1.28</td>
</tr>
<tr>
<td>Control change</td>
<td>12</td>
<td>0.90</td>
</tr>
<tr>
<td>Legal/scandal</td>
<td>6</td>
<td>0.45</td>
</tr>
<tr>
<td>No reason</td>
<td>42</td>
<td>3.16</td>
</tr>
<tr>
<td><strong>Forced</strong></td>
<td><strong>171</strong></td>
<td><strong>12.86</strong></td>
</tr>
<tr>
<td><strong>Total turnovers</strong></td>
<td><strong>1,330</strong></td>
<td><strong>100.00</strong></td>
</tr>
<tr>
<td>less deaths</td>
<td>(37)</td>
<td></td>
</tr>
<tr>
<td><strong>Turnovers used in tests</strong></td>
<td><strong>1,293</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Lexis-Nexis and Dow Jones News Retrieval

categorize turnovers classified as “fired,” “poor performance,” “pursue other interests,” “policy difference,” “control change,” “legal or scandal,” and “no reason” as forced, and remaining reasons as non-forced. We double-checked this categorization by reading articles describing all turnovers, and verifying that “forced” or “non-forced” is the most reasonable characterization of the CEO’s departure. The most common reason provided for the turnovers in our sample is “retirement” (including “early retirement”), followed by “assume another position within the firm” (generally chairman of the board or of the executive committee).

Ideally, our sample would consist of involuntary turnovers. However, as in previous research,
we note that it is not always possible to determine from press articles whether a turnover was forced. Prior studies (e.g., Warner et al. (1988) or Defond and Park (1999)) discuss the unreliable nature of press accounts of turnover and suggest that involuntary turnovers are often presented as retirements. Accordingly, we include all turnovers in our sample, except those arising from the death of the CEO.\textsuperscript{14} We address the potential issue of involuntary turnovers misclassified as retirement by including as controls two age-based variables — CEO Age and a dummy for whether the CEO is at retirement age. Following earlier work, we define retirement age to be between 64 and 66 years of age, and note that our results are robust to alternative definitions. Given the difficulty of isolating involuntary turnovers, we use two measures of turnover in our tests: TURN, which equals one for all firm-years where there is CEO turnover and zero otherwise, and FORCED, which equals one for all firm-years where there is a CEO turnover that we classify as forced and zero otherwise. Our tests use a sample that includes 1,293 turnovers, 171 (approximately 13.2% of the sample) of which have been identified as forced. This fraction of forced is somewhat smaller than that identified by Warner et al. (1988), who use a sample of 279 management changes, 56 of which (20%) they identify as forced.

The firm-years in the Forbes data where no turnovers occur comprise the remainder of our sample. As with the turnover sample, we drop any firm for which there are gaps in the firm’s appearance in the data and the CEO changes during that gap. After satisfying the requirements for age and the noise and timeliness data, we are left with 13,553 firm-years in which there was no CEO turnover. For all sample firms, we use CRSP and Compustat to obtain returns and accounting data, respectively.

4 Model and Analysis

In this section, we examine how the determinants of CEO turnover vary with earnings timeliness and performance measure noise. We begin by estimating our most basic specification, allowing the probability of turnover in year $t$ to depend on year $t - 1$ stock and accounting performance, CEO age, a dummy variable for whether the CEO is at retirement age and year dummy variables. We use two-digit industry-adjusted stock returns, Return$_{-1}$, as our stock

\textsuperscript{14}Weisbach (1988) drops instances of CEO death from his analysis. Weisbach also excludes CEO turnover arising from control changes, arguing that such turnovers are verifiably not retirements. We include control changes in our sample, as it is plausible that many takeovers and mergers are related to CEO and firm performance issues and are thus part of an external monitoring mechanism. All results relating to the association between turnover probabilities and performance measures are qualitatively similar if these observations are dropped.
measure and industry-adjusted change in earnings before interest, tax and minority interest, deflated by beginning assets, EBIT\textsubscript{t-1}, as our accounting measure. Each measure is calculated for the most recent fiscal year ending prior to the year of the turnover. Similar specifications have been estimated in prior work on CEO turnover; for example, Weisbach (1988) uses industry-adjusted change in EBIT deflated by beginning assets and market-adjusted returns.\textsuperscript{15} Industry adjustments are calculated in the same manner as the industry adjustments described in section 2.

We apply industry adjustments here because we expect boards to be able to filter out industry trends in making CEO retention decisions. Note that while the empirical support for relative performance evaluation in CEO compensation is weak (see, for example, Janakiraman, Lambert and Larcker (1992)), there is evidence suggesting relative performance evaluation is more prevalent in retention decisions (see Barro and Barro (1990) and Blackwell, Brickley and Weisbach (1994)). This distinction between compensation and retention decisions may stem from the extent to which explicit contracts are used in these arenas. Compensation contracts often explicitly incorporate firm-level performance measures into compensation formulas (see Murphy (2000b)), and any application of industry-level adjustments to explicit contracts would require an \textit{ex ante} agreement over an appropriate comparison group. These additional contracting costs may lead firms to elect not to use relative measures of performance in compensation. Conversely, explicit contracts rarely spell out specific performance criteria for continued CEO employment, and it would be relatively straightforward for boards making such decisions to adjust for overall industry trends in a subjective, \textit{ex post} manner.\textsuperscript{16}

Although our analyses assume that the use of industry-adjusted performance measures is appropriate for a model of turnover decisions, whether adjusted information is actually used is an empirical question. We conduct estimations that separately include both unadjusted (i.e., firm-specific) and industry performance measures. As Barro and Barro (1990) observe, if pure relative performance evaluation is conducted by firms, we would expect the coefficients on firm

\textsuperscript{15}We also re-estimated our models using earnings before extraordinary items and discontinued items and net income as measures of accounting performance. Results with these alternative earnings measures are qualitatively similar to those reported in sections 4.1 and 4.2.

\textsuperscript{16}Note that this reasoning suggests that Sloan’s (1993) argument for why earnings factor into compensation decisions — namely, to shield executives from market risk contained in stock prices but not in earnings — would not apply to retention decisions. Sloan’s argument requires that boards elect to contract on raw returns rather than market- or industry-adjusted returns.
and industry performance to be of similar magnitude, but opposite in sign. The results of our estimations are qualitatively similar to those in Barro and Barro (1990) in that the coefficients on firm and industry market return performance are both significant and of opposite sign, while only the firm accounting performance is significant. These results suggest that perhaps pure relative performance evaluation is not used by firms with respect to accounting information. As a specification check, we conduct all of our analyses using industry-adjusted market return information and firm-specific (unadjusted) earnings measures. Results of our hypothesis tests using this alternative specification are qualitatively similar to those presented in sections 4.1 and 4.2.

Table 2 presents summary statistics for our primary explanatory variables. We list statistics for the full sample (TURN = 0 or 1), the turnover sample (TURN = 1), the forced turnover sample (FORCED = 1), and the control sample (TURN = 0) in Panels A through D, respectively. Not surprisingly, market and accounting returns are lowest in the sample of FORCED turnover, somewhat higher for the TURN sample, and higher still for the control sample. For firms where CEO turnover is forced, the prior year’s market return averages 2.1% below the rest of the industry, and change in EBIT over assets averages 1.1% below. The TURN sample, which encompasses the FORCED sample, features industry-adjusted market returns of 8.5% and industry-adjusted change in accounting returns of 0.2%. The control sample shows industry-adjusted market returns of 13.8% and industry-adjusted change in accounting returns of 0.8%. The significantly ($p$-value < 0.0001) higher mean and median CEO Age in the TURN sample than in the others is consistent with classification of retirements as non-forced.

Table 2 also includes descriptive statistics for our measures of earnings timeliness and performance measure variance. While we have no expectation that the level of the variance measures should vary across the sub-samples, Basu’s (1997) finding of higher timeliness for bad news firms suggests we might observe a higher level of ER_RSQ for turnover firms. Consistent with this, we note that the level of ER_RSQ in our FORCED sample is significantly (at the 2% level) higher than that in the control sample, although this relation does not hold for the TURN sample. We also observe significantly ($p$-value < 0.0001) higher levels of each variance measure in

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17 We note that CRSP-industry-adjusted returns are fairly high in our sample. These results are likely due to the sample selection induced by the Forbes list. As Murphy and Zimmerman (1993) note, firms tend to enter the Forbes list when growth rates are high. We repeat our analysis using the sample of Forbes firms as our industry comparison group. This adjustment leads to lower industry-adjusted returns, and the results of our hypothesis tests are qualitatively unchanged.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Full sample (N=14,846)</th>
<th>TURN sample (N=1,293)</th>
<th>FORCED sample (N=171)</th>
<th>Control sample (N=13,553)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>St. Dev.</td>
<td>Mean</td>
</tr>
<tr>
<td>Return&lt;sub&gt;-1&lt;/sub&gt;</td>
<td>0.133</td>
<td>0.086</td>
<td>0.342</td>
<td>0.085</td>
</tr>
<tr>
<td>EBIT&lt;sub&gt;-1&lt;/sub&gt;</td>
<td>0.008</td>
<td>0.004</td>
<td>0.058</td>
<td>0.002</td>
</tr>
<tr>
<td>Age</td>
<td>58.17</td>
<td>59.00</td>
<td>6.65</td>
<td>62.42</td>
</tr>
<tr>
<td>ER&lt;sub&gt;RSQ&lt;/sub&gt;</td>
<td>0.450</td>
<td>0.445</td>
<td>0.248</td>
<td>0.444</td>
</tr>
<tr>
<td>EarnVar</td>
<td>0.001</td>
<td>0.0003</td>
<td>0.006</td>
<td>0.001</td>
</tr>
<tr>
<td>RetVar</td>
<td>0.005</td>
<td>0.004</td>
<td>0.005</td>
<td>0.005</td>
</tr>
<tr>
<td>VarRatio</td>
<td>0.171</td>
<td>0.059</td>
<td>0.540</td>
<td>0.154</td>
</tr>
</tbody>
</table>

Full sample includes all TURN observations and all control observations. TURN sample is comprised of firm-years where CEO changed. FORCED sample is comprised of firm-years where CEO was forced out. Control sample is comprised of firm-years where no turnovers occur. Variable definitions: Return<sub>-1</sub> is industry-median-adjusted stock return. EBIT<sub>-1</sub> is industry-median-adjusted change in earnings before interest, taxes, and minority interest, divided by beginning assets. Each variable is measured in year \( t - 1 \), where year \( t \) is the year in which turnover is measured. ER<sub>RSQ</sub> is the \( R^2 \) from annual, firm-specific reverse regressions presented in equation (1). ER<sub>RSQ</sub> numbers are presented prior to the Fisher transformation for ease of interpretation. EarnVar is the variance of industry-median- adjusted core earnings. RetVar is the variance of industry-median-adjusted returns. VarRatio is the ratio of EarnVar to RetVar.
the FORCED sample than in the TURN and control samples. The differences in ER_RSQ and the variance measures across sub-samples reinforce the inclusion of the direct effects of these variables in our tests to control for this variation. We also observe (not tabulated) that the correlation between ER_RSQ and the earnings variance proxies is small (approximately 0.01) and not significant ($p$-value=.21 and .20 for EarnVar and VarRatio, respectively), suggesting that our proxies for the signal and noise properties of earnings are capturing distinct phenomena.18

We present results of basic logit regressions of turnover decisions on performance measures and age controls in Columns 1 and 4 of Table 3 using the TURN and FORCED dependent variables, respectively. Parameters presented in Table 3 are the partial derivatives with respect to the independent variable of the probability of departure, evaluated at the medians of the variables. In Column 1, the regression with TURN as dependent variable shows that both accounting- and market-based performance measures are significantly associated with the probability of turnover. When industry-adjusted returns are ten percentage points lower, the likelihood of CEO departure increases by 0.31 percentage points. This estimate is significantly different from zero at better than the 1% level. Similarly, when the industry-adjusted earnings change scaled by assets is ten percentage points lower, the likelihood of turnover is higher by 0.71 percentage points. The coefficient on industry-adjusted earnings is significant at the 5% level (one-sided test). The economic significance of these results is comparable to those in prior studies of the performance/CEO turnover relation (Weisbach (1988) and Warner et al. (1988), among others). Older CEOs are also more likely to turn over, with each additional year of age increasing departure probability by 0.4 percentage points. CEOs are also 7.9 percentage points more likely to depart when at the standard retirement ages of 64-66. As in prior research, the age variables appear to be the most important factors in predicting turnover when the sample includes both forced and non-forced turnovers.

When FORCED is used as a dependent variable (Column 4), industry-adjusted accounting and stock returns are significant predictors of departure, with significance levels below the 5% and 1% levels, respectively, in one-sided tests. In contrast to the results in the TURN estimation, the Age variable is now significantly negative. Whereas older CEOs were more likely to depart in the regression of Column 1, we find that older CEOs are less likely to be forced out. This may be due in part to classification, as news accounts of departure of older CEOs may be more likely to indicate retirement even when the CEO is, in fact, asked to leave by the board. The

18Similarly, Lambert and Larcker (1987) find that the earnings/return correlation is virtually uncorrelated with their relative noise proxy.
negative relation between Age and forced turnover probability is also consistent with a learning story in which the board’s prior about CEO ability is more precise for older CEOs, implying lesser sensitivity of departure probability to new information for older executives.

4.1 Impact of Signal and Noise on CEO Turnover

Having established that both accounting- and market-based information appears to be associated with CEO turnover decisions, we now examine variation in this association. In the remaining columns of Table 3, we incorporate our proxies for the strength of the earnings signal and for earnings and return noise. We include each proxy directly in our regression as an explanatory variable, and also interact the proxies with our earnings and return measures. While the noise proxies also serve as an important control in the model, our primary interest is in the interaction of our proxies and the performance measures. With respect to our signal proxy, earnings timeliness (ER_RSQ), we expect that when the strength of earnings as a signal increases, any increase in industry-adjusted earnings should result in a larger reduction in the likelihood of turnover. Likewise, as the strength of the earnings signal decreases, any increase in industry-adjusted returns should result in a larger reduction in the likelihood of turnover. We therefore expect a negative coefficient on the interaction of earnings and ER_RSQ and a positive coefficient on the interaction of returns and ER_RSQ.

We also expect that when the variance of each performance measure increases, an increase in the performance measure will result in a smaller reduction in the likelihood of turnover. Thus, we expect positive coefficients on both the interaction of earnings with EarnVar and the interaction of returns with RetVar. In addition, we conduct estimations that replace the individual variances of the performance measures with a relative variance measure, VarRatio, and expect that the magnitude of the coefficient on earnings (returns) should be a decreasing (increasing) function of VarRatio. We therefore predict a positive (negative) coefficient on the interaction of earnings (returns) with VarRatio.

We begin by estimating our logit model using our earnings timeliness proxy (ER_RSQ) and the individual performance measure variance proxies (EarnVar and RetVar) for both the TURN and FORCED dependent variables (Columns 2 and 5). We then consider the relative noise variable (VarRatio) in place of the individual variance measures (Columns 3 and 6).

The results in Columns 2 and 5 support the hypotheses that earnings timeliness and earnings variance measures affect the weights on earnings information in turnover decisions. The coefficients on EBIT_{-1} * ER_RSQ are negative and significant at below the 5% and 1% lev-
Table 3: Logit Analysis of CEO Turnover Regressed on Accounting and Stock Performance Measures, Signal and Noise Proxies, and Control Variables

<table>
<thead>
<tr>
<th>Expected Dep. var. = TURN</th>
<th>Dep. var. = FORCED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sign</strong></td>
<td>(1)</td>
</tr>
<tr>
<td>Return_{-1}</td>
<td>-0.031&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(4.28)</td>
<td>(-2.25)</td>
</tr>
<tr>
<td>EBIT_{-1}</td>
<td>-0.071&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>(2.13)</td>
<td>(-0.36)</td>
</tr>
<tr>
<td>Age_{64,66}</td>
<td>0.079&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(7.78)</td>
<td>(7.57)</td>
</tr>
<tr>
<td>Age</td>
<td>0.004&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(7.12)</td>
<td>(6.96)</td>
</tr>
<tr>
<td>ER_RSQ</td>
<td>0.002</td>
</tr>
<tr>
<td>(1.26)</td>
<td>(-0.50)</td>
</tr>
<tr>
<td>EBIT_{-1} * ER_RSQ</td>
<td>-0.117&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>(1.79)</td>
<td>(-1.97)</td>
</tr>
<tr>
<td>Return_{-1} * ER_RSQ</td>
<td>0.009</td>
</tr>
<tr>
<td>(0.69)</td>
<td>(0.64)</td>
</tr>
<tr>
<td>EarnVar</td>
<td>-0.616</td>
</tr>
<tr>
<td>(-2.75)</td>
<td>(-1.03)</td>
</tr>
<tr>
<td>EBIT_{-1} * EarnVar</td>
<td>5.362&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(2.75)</td>
<td>(2.46)</td>
</tr>
<tr>
<td>RetVar</td>
<td>1.015&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(3.22)</td>
<td>(3.63)</td>
</tr>
<tr>
<td>Return_{-1} * RetVar</td>
<td>-0.334</td>
</tr>
<tr>
<td>(-0.52)</td>
<td>(2.07)</td>
</tr>
<tr>
<td>VarRatio</td>
<td>-0.007</td>
</tr>
<tr>
<td>(-1.41)</td>
<td>(-0.46)</td>
</tr>
<tr>
<td>EBIT_{-1} * VarRatio</td>
<td>0.087&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>(2.60)</td>
<td>(2.49)</td>
</tr>
<tr>
<td>Return_{-1} * VarRatio</td>
<td>-0.010</td>
</tr>
<tr>
<td>(-0.77)</td>
<td>(1.05)</td>
</tr>
</tbody>
</table>

Dependent variable TURN is an indicator for CEO turnover. Dependent variable FORCED is an indicator for whether CEO was forced out. All other variables are as defined in Table 2. Parameters are estimates of the marginal effect on the probability of departure of an increase in the independent variable. <i>t</i>-statistics in parentheses. Year indicators (not reported) are included as controls. <sup>a</sup>, <sup>b</sup>, and <sup>c</sup> denote significance of coefficients at the 1%, 5%, and 10% levels, respectively (one-sided test where sign is predicted; two-sided test otherwise).
els in the TURN and FORCED models, respectively. Further, the coefficients on EBIT\(_{-1}\) \* EarnVar are positive and significant as predicted at below the 1% levels in both models. While we are primarily interested in the statistical significance of the relation, we can also interpret the parameter estimates by comparing the predicted coefficients on EBIT\(_{-1}\) for firms in the 10th and 90th percentiles of our proxy variables. For example, using the TURN model, we can compare the slope of the earnings/turnover probability link for firms with high and low timeliness. Setting the other variables to their median values, we find that for a high timeliness (90th ER\(_{RSQ}\) percentile) firm, a one percentage point reduction in EBIT\(_{-1}\) corresponds to a 0.183 percentage point increase in turnover probability. A similar reduction in EBIT\(_{-1}\) for a low timeliness (10th ER\(_{RSQ}\) percentile) firm produces a 0.063 percentage point increase in turnover probability. Hence, turnover probabilities increase faster with reductions in earnings for firms with timelier earnings.

In contrast with the earnings results, support for the impact of earnings timeliness and return variance on the market return/turnover probability link is restricted to the FORCED model. We find a marginally significant (at the 10% level) coefficient on Return\(_{-1}\) \* ER\(_{RSQ}\) in the FORCED model, but not in the TURN model. Likewise, the coefficient on interaction of Return\(_{-1}\) with RetVar is significant (at the 5% level) only in the FORCED model.

We note that the coefficients on the direct effects of ER\(_{RSQ}\) and EarnVar are not significant in either the TURN or FORCED models, suggesting that CEOs of firms with higher earnings

\(^{19}\text{The partial derivative of turnover probability is calculated from the logit coefficients in the following way. Given the formula for the logit regression, } P = \frac{\exp(a + bX)}{1 + \exp(a + bX)}, \text{ where } P \text{ is the predicted probability of turnover, the derivative of this probability with respect to } X \text{ can be calculated as } \frac{dP}{dX} = -\frac{b \exp(a + bX)^2}{(1 + \exp(a + bX)^2)} + \frac{b \exp(a + bX)}{(1 + \exp(a + bX)^2)} = -bP^2 + bP. \text{ The logit coefficients (corresponding to the probability derivatives presented in Column 2 of table 3) yield the following equation for } a + bX: \}

\[ a + bX = -7.641 - 0.639 \text{ Return}_{-1} - 0.462 \text{ EBIT}_{-1} + 1.519 \text{ Age}_{64,66} + 0.080 \text{ Age} - 0.051 \text{ ER}_{RSQ} \\
- 2.392 \text{ EBIT}_{-1} \* \text{ ER}_{RSQ} + 0.178 \text{ Return}_{-1} \* \text{ ER}_{RSQ} - 12.551 \text{ EarnVar} + 109.334 \text{ EBIT}_{-1} \* \text{ EarnVar} \\
+ 20.694 \text{ RetVar} - 6.814 \text{ Return}_{-1} \* \text{ RetVar} + \text{ year coefficients} \* \text{ year indicators}. \]

Evaluating \(a + bX\) at the 90th percentile of ER\(_{RSQ}\) (1.417) and the medians of all other variables (Return\(_{-1}\): 0.086, EBIT\(_{-1}\): 0.004, Age: 59, EarnVar: 0.0003, RetVar: 0.004, indicator medians all zero) yields \(a + bX = -2.937\), which implies \(P = 0.050\). The probability derivative with respect to the linear effect of EBIT\(_{-1}\) is then 0.462 (0.050)\(^2\) - 0.462 (0.050) = -0.022; similarly, the probability derivatives with respect to EBIT\(_{-1}\) \* ER\(_{RSQ}\) and EBIT\(_{-1}\) \* EarnVar are -0.114 and 5.232, respectively. Combining these effects yields the total derivative of probability of turnover with respect to EBIT\(_{-1}\) for the 90th ER\(_{RSQ}\) percentile: -0.022 -0.114 (1.417) + 5.232 (0.0003) = -0.183. The probability derivative at 10th percentile of ER\(_{RSQ}\) (0.347) is calculated analogously.
timeliness and earnings variance are not markedly more or less likely to turn over compared to CEOs of firms with lower earnings timeliness and lower earnings variance. As discussed earlier, ER_RSQ might be expected to be higher for bad news firms. In this case, we would expect to find that higher ER_RSQ means a higher likelihood of turnover, but this effect is not present. In contrast, the coefficient on the direct effect of RetVar is positive and significant in both the TURN and FORCED models. This result is consistent with prior work (for example, see Defond and Park (1999)) and suggests a greater likelihood of CEO turnover for firms with larger stock return variance. Recall that our model offers no predictions about the direct effects of the variance of earnings and returns; rather, these measures serve as controls that allow us to interpret the interaction terms.

We next conduct similar estimations to those above substituting a relative noise variable (VarRatio) in place of the individual variance measures. Recall that our model suggests that controlling for variance is important in our interpretation of the timeliness parameter. In this specification, our control for variance incorporates a different assumption from that in Columns 2 and 5 — here, the noise variable VarRatio controls for variance by holding constant the relative variances of the performance measures. Columns 3 and 6 report that the coefficients on the ER_RSQ interactions with both earnings and returns are similar in the alternative model to those in Columns 2 and 5. We also continue to document a significant coefficient on the interaction of earnings timeliness with market returns in the FORCED model. We find that the coefficient on the interaction of VarRatio with EBIT\_{-1} is positive and significant, as predicted, at the 1% level in both the TURN and FORCED models, indicating that turnover probabilities increase faster with reductions in earnings for firms with relatively less variable earnings. The coefficient on the interaction of Return\_{-1} with VarRatio is not significantly different from zero in either Column 3 or 6. We observe that, as before, the coefficients on the direct effect of ER_RSQ are not significantly different from zero and also note that the coefficient on the direct effect of VarRatio is not significant.

We conduct a variety of sensitivity analyses, which we omit from the tables for brevity. First, we explore alternative measures of earnings to construct our signal and noise proxies. Specifically, we replace core earnings with EBIT (earnings before interest, tax and minority interest) and core earnings before taxes when computing the variance terms and the earnings timeliness metrics. We first observe that the signal and noise proxies used in our main analyses are highly correlated ($p$-values < .0001) with the corresponding proxies computed using the two alternative earnings definitions. Further, results of the logit estimations using the proxies
computed with EBIT are similar to those shown in Table 3, with the following minor exceptions: the coefficient on $\text{EBIT}_{-1} \times \text{VarRatio}$ loses significance in the Column 3 regression, while the coefficient on $\text{Return}_{-1} \times \text{VarRatio}$ gains significance in the Column 6 regression. Similar findings are also obtained when core earnings before taxes is used in our proxies, although these regressions provide somewhat stronger support for the return hypothesis with respect to earnings timeliness, as compared to the results in Table 3.

We also conduct sensitivity analyses relating to how we empirically specify our model in section 2. First, we consider an alternative proxy for earnings timeliness in place of $\text{ER}_{RSQ}$. We observe that, like $\text{ER}_{RSQ}$, the correlation between the two performance measures is an increasing function of the timeliness parameter $\gamma$ in our model, holding performance measure variances constant. We re-estimate our logit regressions using the univariate correlation between market returns and earnings as the earnings timeliness proxy. Results with the alternative earnings timeliness proxy are qualitatively similar to those reported in Table 3. Second, following the model, we allow performance measures variances to enter the estimation nonlinearly. As we discuss in section 2 and in the appendix, controls for the variances of earnings and market returns are important in allowing us to empirically evaluate the role of earnings timeliness on the turnover/performance relation. The model suggests that the variance terms enter the relation between performance measure correlation and $\gamma$ in a nonlinear fashion. We consider this in our estimation by including two alternative variance proxies for each performance measure — the square and square root of variance of earnings and returns are included in our estimations. Results for the timeliness proxy when the nonlinear variances are included are similar to those reported in Table 3.

In summary, the results in Table 3 are consistent with our hypothesis that earnings properties affect the weight on accounting information in firms’ CEO turnover decisions. Using proxies for signal and noise in performance measures and two different definitions of turnover, we find that the weight on accounting-based performance measures in CEO turnover decisions appears to vary systematically with the signal and noise properties of accounting information. When we focus on the sample of turnovers identified as forced, we also find the weight placed on market returns in turnover decisions is decreasing in earnings timeliness and in the variance of returns.
4.2 Earnings Properties and Industry Concentration

In this section we revisit Defond and Park’s (1999) analysis of the link between industry concentration and the use of industry-adjusted accounting information in CEO turnover decisions. Defond and Park (1999) argue that firms in less concentrated industries have a larger set of comparison firms. Consequently, industry earnings provide a more precise signal of factors affecting firms in that industry, meaning that industry-adjusted earnings are a better signal of managerial performance at individual firms. Defond and Park’s (1999) main hypothesis is that industry concentration can explain cross-sectional variation in the use of industry-adjusted earnings in CEO turnover. Using a sample of 2,730 firm-years between 1988 and 1992, they find support for this assertion.

Given that our analysis also studies cross-sectional variation in the use of accounting information in turnover, we are interested in examining which effect is driving the two sets of findings. That is, it may be that industry concentration is the key determinant of use of accounting information, and our variance and timeliness measures are somehow proxying for concentration (or vice versa). Alternatively, the two effects may be separately identifiable in the data.

To address these issues, we extend our specification from Table 3 to incorporate Defond and Park’s (1999) measure of industry concentration. In Table 4, we include all variables from Table 3 (including Age and Age64,66, which are omitted from the table for brevity) and add both a dummy variable for industry concentration (which we call ConcDum) and the interaction of the dummy with both EBIT\textsuperscript{−1} and Return\textsuperscript{−1}. We measure industry concentration in the same

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\textsuperscript{20}Defond and Park (1999) refer to less concentrated industries as being more “competitive.” However, the link between concentration and competition is complicated by the issue of market definition. Consider, for example, the comparison between an industry consisting of a large number of regional monopolies (such as SIC 49 — electric, gas and sanitary services) and an industry consisting of a small number of national competitors (such as SIC 45 — transportation by air). The industry with regional monopolies will feature a lower concentration than that with national competitors if concentration is measured at the national level. If, on the other hand, concentration is measured at the regional level, the regional monopoly industry will appear more concentrated.

\textsuperscript{21}Our reconsideration of Defond and Park (1999) result is subject to an important caveat. Our analysis features a broader sample period and somewhat different explanatory variables (e.g., we do not consider analyst earnings forecast errors, and they do not interact concentration with industry-adjusted stock returns), and thus should not be interpreted as a replication of their findings. In untabulated results, we included analyst forecast errors, both directly and interacted with concentration, in our regressions. Our primary conclusions were unchanged in this specification.
manner as Defond and Park (1999), by calculating (for each firm-year) the Herfindahl Index for that firm’s two-digit SIC industry. This index is computed as the sum of the squares of the market shares of the firms in the industry, where market share is defined as firm sales divided by total industry sales. We then define a dummy variable (ConcDum) to be equal to one if the industry concentration is higher than the sample median.\textsuperscript{22} Including this dummy variable directly in our regression allows the overall likelihood of CEO turnover to vary across more and less concentrated industries. The interaction terms allow the sensitivity of turnover probability to earnings and returns to vary across the concentration groups as well. As in Defond and Park (1999), we also include measures of industry market-to-book ratios (IndMB) and the variance of stock return (RetVar) as control variables for the firm’s investment opportunity set and stock return volatility, respectively.\textsuperscript{23} We compute an annual measure of industry market-to-book ratios using two-digit SIC codes to define industry.

We find some evidence that CEO turnover is more common in less concentrated industries, implying average tenures are shorter in these industries. This finding is consistent with the Defond and Park (1999) hypothesis that boards learn more quickly about abilities of CEOs in these industries, and thus can remove poor CEOs sooner. Note, however, that this result (i.e., ConcDum < 0) holds only in our broader TURN sample. We also find some support for Defond and Park’s (1999) hypothesis that the use of industry-adjusted earnings measures varies with industry concentration. As with our earlier tests, our sample of forced turnovers provide the strongest support for this hypothesis. When FORCED is the dependent variable (Columns 4 through 6 of Table 4), we find that the coefficients on EBIT\textsuperscript{-1} * ConcDum are significant and positive as predicted (at the 10% or better level), suggesting that turnover probabilities increase faster with reductions in industry-adjusted earnings in less concentrated industries. In the TURN sample (Columns 1 through 3 of Table 4), the coefficients on EBIT\textsuperscript{-1} * ConcDum are not statistically significant.

In contrast, our estimates do not suggest that use of industry-adjusted stock returns varies with industry concentration. While Defond and Park (1999) do not consider how use of this measure might vary with concentration, their arguments linking concentration with relative

\textsuperscript{22}Defond and Park (1999) use a dummy variable for “competitiveness” rather than “concentration;” as a result, our dummy is the inverse of theirs.

\textsuperscript{23}We use RetVar as our measure of stock return volatility for consistency across our tests. For comparability with Defond and Park (1999), we also ran the tests using industry standard deviation of returns in place of RetVar. Our inferences were qualitatively unchanged in this specification.
<table>
<thead>
<tr>
<th>Sign</th>
<th>Dep. var. = TURN</th>
<th>Dep. var. = FORCED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Return_{-1}</td>
<td>-0.052^{a}</td>
<td>-0.053^{b}</td>
</tr>
<tr>
<td></td>
<td>(-3.45)</td>
<td>(-2.09)</td>
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<tr>
<td>EBIT_{-1}</td>
<td>-0.106^{c}</td>
<td>-0.081</td>
</tr>
<tr>
<td></td>
<td>(-1.48)</td>
<td>(-0.65)</td>
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<tr>
<td>ConcDum</td>
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<td>-0.013^{a}</td>
</tr>
<tr>
<td></td>
<td>(-2.20)</td>
<td>(-2.19)</td>
</tr>
<tr>
<td>EBIT_{-1} \ast ConcDum</td>
<td>0.008</td>
<td>0.035</td>
</tr>
<tr>
<td></td>
<td>(-0.08)</td>
<td>(0.35)</td>
</tr>
<tr>
<td>Return_{-1} \ast ConcDum</td>
<td>0.006</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>(0.30)</td>
<td>(0.22)</td>
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<tr>
<td>ER_RSQ</td>
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<td>-0.005</td>
</tr>
<tr>
<td></td>
<td>(-0.74)</td>
<td>(-0.78)</td>
</tr>
<tr>
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<td>-0.177^{c}</td>
<td>-0.182^{c}</td>
</tr>
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<td></td>
<td>(-1.56)</td>
<td>(-1.58)</td>
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<tr>
<td>Return_{-1} \ast ER_RSQ</td>
<td>0.015</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>(0.71)</td>
<td>(0.66)</td>
</tr>
<tr>
<td>EarnVar</td>
<td>-0.857</td>
<td>-0.169</td>
</tr>
<tr>
<td></td>
<td>(-1.06)</td>
<td>(-0.61)</td>
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<tr>
<td>EBIT_{-1} \ast EarnVar</td>
<td>8.810^{a}</td>
<td>2.815^{b}</td>
</tr>
<tr>
<td></td>
<td>(2.65)</td>
<td>(2.07)</td>
</tr>
<tr>
<td>RetVar</td>
<td>1.486^{a}</td>
<td>1.559^{a}</td>
</tr>
<tr>
<td></td>
<td>(3.08)</td>
<td>(2.94)</td>
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<tr>
<td>Return_{-1} \ast RetVar</td>
<td>-0.910</td>
<td>0.636^{b}</td>
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<tr>
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<td>(-1.42)</td>
<td>(-0.81)</td>
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<tr>
<td>EBIT_{-1} \ast VarRatio</td>
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<td>0.065^{a}</td>
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<tr>
<td></td>
<td>(2.69)</td>
<td>(2.45)</td>
</tr>
<tr>
<td>Return_{-1} \ast VarRatio</td>
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<td>-0.000</td>
</tr>
<tr>
<td></td>
<td>(-0.99)</td>
<td>(-0.07)</td>
</tr>
<tr>
<td>IndMB</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(0.34)</td>
<td>(0.34)</td>
</tr>
<tr>
<td>N</td>
<td>14,410</td>
<td>14,410</td>
</tr>
<tr>
<td>N(Turn or Forced)</td>
<td>1,283</td>
<td>1,283</td>
</tr>
<tr>
<td>N(Control)</td>
<td>13,127</td>
<td>13,127</td>
</tr>
<tr>
<td>Pr &gt; ChiSq</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Dependent variable TURN is an indicator for CEO turnover. Dependent variable FORCED is an indicator for whether CEO was forced out. ConcDum=1 if industry concentration > median industry concentration; 0 otherwise. IndMB=industry market-to-book ratio. All other variables are as defined in Table 2. Parameters are estimates of the marginal effect on the probability of departure of an increase in the independent variable. For dummy variables, parameter is the estimated increase in probability of departure when dummy increases from zero to one. $t$-statistics in parentheses. Year indicators are included as controls. Age and Age\_{64,66} are included in regression but omitted from table for ease of presentation. $a$, $b$, and $c$ denote significance of coefficients at the 1%, 5%, and 10% levels, respectively (one-sided test where sign is predicted; two-sided test otherwise).
performance evaluation would seem to apply equally as well to industry-adjusted stock returns as to industry-adjusted earnings. One might expect, therefore, to find positive coefficients on the interaction between industry-adjusted stock returns and the concentration dummy. Our point estimates, however, are not significant.

The results in Table 4 do not change the conclusions we drew from Table 3 above. We again find support for the assertion that earnings properties affect the strength of the earnings/turnover link. The coefficients on EBIT\(_{-1}\) * ER_RSQ are comparable in magnitude to those obtained in Table 3, and attain significance at better than the 5% and 10% levels when the dependent variables are FORCED and TURN, respectively. Likewise, the coefficients on EBIT\(_{-1}\) interacted with the absolute and relative earnings variance terms remain significantly positive. As in Table 3, when FORCED is the dependent variable, the coefficient on Return\(_{-1}\) interacted with VarRet remains significantly positive, and we continue to find some evidence consistent with a negative relation between earnings timeliness and the weight on market returns. Finally, we note that coefficients and significance levels for the two Age variables (untabulated) are comparable to those presented in Table 3.

The evidence contained in Table 4 supports the assertion that both industry concentration and properties of accounting information are helpful in explaining cross-sectional variation in the use of accounting-based performance measures in CEO turnover. These regressions indicate that even holding industry concentration fixed, ER_RSQ and the earnings variance measures, EarnVar and VarRatio, are useful in explaining across-firm patterns in use of accounting in retention decisions. Similarly, holding earnings timeliness and variance fixed, concentration still offers explanatory power. We find, however, that lower industry concentration does not result in increased reliance on industry-adjusted stock returns. Further, our findings from Table 3 of positive coefficients on Return\(_{-1}\) * ER_RSQ and Return\(_{-1}\) * RetVar in the FORCED models are robust to the inclusion of industry concentration measures.

5 Conclusion

Our objective in this paper is to examine how the weights on accounting- and market-based performance measures in CEO turnover decisions are related to their properties as measures of managerial performance. Multiple-performance-measure agency theory suggests that factors associated with the signal-to-noise ratio of performance measures should influence their weights in evaluating and rewarding manager performance. We present such a model in the appendix,
and use it to develop conditions under which a higher association between earnings and returns implies a greater weight on earnings in managerial incentive arrangements.

While this association has been used in much prior work on properties of earnings as a managerial performance measure, there appears to be no consensus in the existing literature as to how this association should be related to the weight on earnings. Some authors (e.g., Bushman et al. (1996)) use the correlation as a measure of the strength of signal contained in accounting information, while others (e.g., Lambert and Larcker (1987) and Ittner et al. (1997)) propose the opposite relation, arguing that earnings that are not informative about firm value can still provide valuable information for evaluating the CEO. Our model incorporates both viewpoints and offers conditions under which each holds. We show that reductions in the earnings/return association make earnings less useful as a performance measure if the reduced association is driven by a decrease in the fraction of current value creation that appears in current earnings. The converse is true if the reduction is driven by increased variation in returns that is unrelated to current value creation.

We apply this reasoning in our empirical analysis. We capture the earnings/return association with a measure of earnings timeliness derived from prior research by Ball et al. (2000) and Bushman et al. (2003). We proxy for noise using measures of earnings and return variance. We hypothesize that directors will place greater reliance on earnings numbers when earnings timeliness is high or when earnings are less noisy. Similarly, we predict that directors will rely more heavily on information in stock returns when earnings timeliness is low or when stock returns are less variable.

We test these hypotheses using data on CEO turnover derived from the Forbes executive compensation surveys and find support for many of our hypotheses. Using our proxies for signal and noise, we find support for the hypothesis that these properties impact the relation between earnings and turnover probabilities. Our results suggest that the weight on earnings information is increasing in timeliness and decreasing in earnings variance.

We find mixed support for the hypothesis that firms rely more heavily on market-based measures when accounting information is less timely or market returns are less variable. Using the sample of turnovers we identified as forced, we find the weight placed on market returns in turnover decisions is decreasing in timeliness and decreasing in the variance of returns. These findings do not hold in our broader sample of all CEO turnovers. We also document the robustness of our results to the inclusion of industry concentration measures. We relate our analysis to Defond and Park’s (1999) argument that the use of industry-adjusted performance information
in turnover decisions is positively impacted by lower levels of industry concentration.
Appendix

We consider a multiple-performance measure principal-agent model like that proposed and studied by Holmstrom and Milgrom (1987, 1991). This linear-contracts agency model is clearly not tailored to the case where incentives are provided by threat of termination, since termination-based incentives are inherently non-linear. As such, we develop this model simply to illustrate the intuition underlying our turnover-related hypotheses.

In period $t$ of our model, a risk-neutral firm contracts with a risk-averse manager to take actions that increase firm value. Within this period, the following events occur. First, the firm and manager agree on a contract. This contract can depend on the firm’s earnings in period $t$ and on the change in the firm’s market value during period $t$. Market value is assumed to be the discounted sum of present and future earnings. Given the contract, the manager selects an effort level $e_t$. Earnings and change in market value for the period are then revealed. Earnings in period $t$ depend on both the current manager’s effort level and the effort level selected by the firm’s period $t-1$ manager. The change in the firm’s market value during period $t$ depends on both the effort level selected by the manager and on random changes in expectations regarding future earnings. The manager is then paid according to the terms of the contract. The process is then repeated in period $t + 1$.

The key assumption in the model is that current managerial effort translates noisily into value creation, but only a fraction $\gamma$ (which we refer to as the firm’s “timeliness parameter”) of current value creation appears in current earnings, with the remainder appearing in the next period’s earnings. We use our model to study how the weights on current earnings and change in market value in the optimal contract vary as earnings become more timely. Our main result is that, holding the variances of earnings and market returns constant, increases in timeliness imply greater use of earnings and lesser use of market returns in the optimal contract.

The intuition for this result is as follows: Both earnings and change in market value have drawbacks as measures of managerial performance. Current earnings reflect only part of current value creation. Changes in market value, on the other hand, reflect all of current value creation.\footnote{For simplicity, we ignore the possibility that the firm could compensate the manager based on both current and future earnings. Also, we assume the effects of managerial remuneration on market value are small.} Changes in market value, on the other hand, reflect all of current value creation.\footnote{This assumption is motivated by characteristics of GAAP such as conservatism that may limit earnings’ ability to reflect value, and has been widely documented in the accounting literature (see, for example, Beaver, Lambert and Ryan (1987) and Kothari and Sloan (1992)).}
creation, but also reflect changes in expectations about future value creation that are orthogonal to the current manager’s actions. Increases in earnings timeliness mitigate the key drawback of earnings as a performance measure without changing the properties of market return. Hence, the optimal contract makes greater use of current earnings and lesser use of changes in market value when timeliness is higher.

Formally, let the manager have a constant coefficient of absolute risk aversion \( \rho \). The manager’s total value creation \( v^m_t \) in period \( t \) depends on his effort \( e_t \) plus noise:

\[
v_t^m \sim N(e_t, \sigma_t^2)
\]

We assume the manager’s effort costs are quadratic, and the random factors affecting managerial value creation are i.i.d. across time (so that \( \sigma_t^2 = \sigma_{t+1}^2 = \sigma^2 \)).

Let \( \Delta V_t \) represent the change in the value of the firm during period \( t \). The manager’s action \( (e_t) \) is anticipated by the market (where \( \hat{e}_t \) denotes the expected action), so the expected change in market value (conditional on the manager taking the equilibrium effort level) is zero. Assume that the variance of the random factors affecting future earnings is \( \sigma_a^2 \), and that \( \sigma_t^2 \) and \( \sigma_a^2 \) are independent. We therefore have

\[
\Delta V_t \sim N(e_t - \hat{e}_t, \sigma_t^2 + \sigma_a^2),
\]

We operationalize the notion that earnings may reflect value creation with a lag by assuming that fraction \( \gamma \) of the manager’s value creation appears in this period’s earnings; the remaining \( 1 - \gamma \) appears in next period’s earnings. Similarly, \( \gamma \) of the variance associated with managerial value creation appears in this period’s earnings, with the remainder appearing next period. We refer to \( \gamma \) as the “timeliness parameter.” Under these assumptions, the firm’s period \( t \) earnings can be written as

\[
EARN_t \sim N(\gamma e_t + (1 - \gamma) e_{t-1}, \gamma \sigma_t^2 + (1 - \gamma) \sigma_{t-1}^2)
\]

Note that while our model here focuses on incentives, an analogous model (with similar results) can be constructed for the case where CEO turnover reflects matching considerations rather than incentives. Consider a normal learning model where a firm updates its beliefs regarding CEO ability in response to accounting- and market-based signals of performance. Let the firm (as in Hermalin and Weisbach (1998)) fire the manager if its belief as to the manager’s ability falls below some cutoff. In such models, it is the signal and noise of the performance signals that determines their weight in the firm’s posterior belief regarding CEO ability. As accounting information becomes more timely, it will have a greater effect on CEO retention decisions.

The assumption that the “rest” of the value (that is, the \( 1 - \gamma \)) shows up in next period’s earnings can be generalized. The important feature is that only part of the value appears today.
Given CARA utility and normal disturbances, a linear wage contract is optimal. Let the manager’s wage contract be

\[
\text{Wage} = \alpha + \beta_e \text{EARN}_t + \beta_v \Delta V_t.
\]

This implies the manager’s period \(t\) wage is distributed as:

\[
\text{Wage} \sim N(\alpha + \beta_e [\gamma e_t + (1 - \gamma) e_{t-1}] + \beta_v (e_t - \hat{e}_t), (\beta_e^2 + \beta_v^2 + 2\gamma \beta_e \beta_v)\sigma^2 + \beta_v^2 \sigma_a^2)
\]

With this setup, it is in the parties’ joint interest to maximize the total certainty equivalent subject to the manager’s incentive constraint. The optimal wage contract solves

\[
\max_{e_t, \beta_v} e_t - \frac{1}{2} \sigma e_t^2 - \frac{1}{2} \sigma ((\beta_e^2 + 2\gamma \beta_e \beta_v + \beta_v^2)\sigma^2 + \beta_v^2 \sigma_a^2)
\]

subject to

\[
e_t = (\gamma \beta_e + \beta_v)/c.
\]

We substitute \(e_t\) and derive the following two first-order conditions:

\[
1 - \beta_e \left(1 + \rho(c(\sigma^2 + \sigma_a^2))\right) - \gamma \beta_e (1 + \rho c \sigma^2) = 0
\]

\[
\gamma - \beta_e (\gamma^2 + \rho c \sigma^2) - \gamma \beta_v (1 + \rho c \sigma^2) = 0
\]

This solution is

\[
\beta_v^* = \frac{(1 - \gamma^2)\sigma^2}{\sigma^2(1 - \gamma^2)(1 + \rho c \sigma^2) + \sigma_a^2(\gamma^2 + \rho c \sigma^2)}
\]

\[
\beta_e^* = \frac{\gamma \sigma_a^2}{(\sigma^2(1 - \gamma^2)(1 + \rho c \sigma^2) + \sigma_a^2(\gamma^2 + \rho c \sigma^2))}
\]

From these expressions, we can prove four propositions.

**Proposition 1** The optimal weight on change in market value in the manager’s wage contract, \(\beta_v^*\), decreases with the timeliness parameter, \(\gamma\).

**Proof:** Differentiate with respect to \(\gamma\).

**Proposition 2** If \(\gamma^2 < \rho c \sigma^2\), then the optimal weight on earnings in the manager’s wage contract, \(\beta_e^*\), increases with the timeliness parameter, \(\gamma\).

**Proof:** Differentiate with respect to \(\gamma\):

\[
\frac{d\beta_e}{d\gamma} = \frac{\sigma_a^2(\sigma^2(1 + \gamma^2)(1 + \rho c \sigma^2) + \sigma_a^2(\rho c \sigma^2 - \gamma^2))}{(\sigma^2(1 - \gamma^2)(1 + \rho c \sigma^2) + \sigma_a^2(\gamma^2 + \rho c \sigma^2))^2}.
\]
Note that if $\gamma^2 < \rho \sigma^2$, then both numerator and denominator are positive. Note also that $\gamma^2 < \rho \sigma^2$ is a sufficient, but not necessary, condition. If $\gamma^2 > \rho \sigma^2$, then $\beta_e^*$ is still increasing in $\gamma$ if

$$\sigma_a^2 < \frac{\sigma^2(1 + \gamma^2)(1 + \rho \sigma^2)}{(\gamma^2 - \rho \sigma^2)}.$$  

We discuss the intuition for the condition in Proposition 2 below.

**Proposition 3** $\beta_e^*$ is decreasing in $\sigma^2$.

*Proof:* Differentiate with respect to $\sigma^2$.

**Proposition 4** $\beta_v^*$ is decreasing in $\sigma_a^2$.

*Proof:* Differentiate with respect to $\sigma_a^2$.

Translating these propositions into testable hypotheses is straightforward. Proposition 3 indicates that the weight on earnings in the incentive contract is decreasing in the variance of earnings. Proposition 4 indicates that the weight on returns is decreasing in the variance of the non-managerial-effort component of returns. Thus, holding constant the variance of earnings, the weight on returns is decreasing in the variance of returns.

With respect to the signal measure, Proposition 1 shows that the weight on returns is decreasing in $\gamma$, while Proposition 2 indicates that, for reasonable parameter values, the weight on earnings is increasing in $\gamma$. To link our model to our empirical specification, we note that our ideal experiment would be to compare two firms with identical $\sigma^2$ and $\sigma_a^2$, but different $\gamma$. Since we do not observe $\gamma$, we look for other measures that capture the relation between earnings and returns. Holding $\sigma^2$ and $\sigma_a^2$ fixed, the correlation between earnings and change in market value is increasing in $\gamma$. Hence, we structure our empirical model to ask whether, holding the variances of earnings and market returns constant, two firms where these measures are differently related place different weights on the two measures.

Finally, while we hypothesize that the weight on earnings in the optimal contract is increasing in timeliness, our model does offer some conditions under which $\beta_e^*$ is decreasing in $\gamma$. Here, we discuss the intuition behind this result, and explain why we expect $\beta_e^*$ to be increasing in $\gamma$ in actual incentive contracts.

From the proof of our Proposition 2, it is immediate that

$$\gamma^2 > \rho \sigma^2$$  \hspace{1cm} (2)
is a necessary condition for $\frac{\partial }{\partial \gamma} \beta_v^* \gamma$ to be less than zero. What is the intuition for this expression? Inequality (2) is likely to hold when

- Earnings are very timely (high $\gamma$).
- The manager is not very risk averse (low $\rho$).
- The manager is not very effort averse (low $c$).
- Managerial effort translates into value with little noise (low $\sigma^2$).

Why, under these conditions, would the optimal weight on earnings be decreasing in $\gamma$? If $\rho c \sigma^2$ is small, then earnings are a very good measure of managerial performance. The firm prefers to place a very high weight on them in the optimal contract. In the extreme case where effort translates perfectly into value ($\sigma^2 = 0$), the firm can achieve the first best by paying the manager 100% of his value creation. Because fraction $\gamma$ of value creation is in current earnings, the firm can achieve the first best by paying the manager $1/\gamma$ dollars for every dollar of earnings. Hence, the weight on earnings can be decreasing in $\gamma$ if $\rho c \sigma^2$ is sufficiently small.

At the level of intuition, there are two effects of increases in timeliness on the weight on earnings in the optimal contract. First, increases in timeliness make the signal in earnings about current managerial actions stronger, leading to an increase in $\beta_v^*$. Second, increases in timeliness mean the firm can achieve a given incentive level with a lower weight on earnings.\footnote{To see this, consider the effects of a 0.5 weight on earnings. If $\gamma = 1$, then this is equivalent to paying the manager 50% of the value he creates. If $\gamma = \frac{1}{2}$, then this is equivalent to paying the manager 25% of the value he creates. If timeliness increases but the firm wants to retain the same incentive level, then it can reduce the weight on earnings.}

Inequality (2) shows that the first effect is stronger unless earnings are an extremely good measure of managerial performance. That is, the “signal-strength effect” dominates as long as there is enough noise to make the firm’s inference problem difficult.

By way of calibrating Inequality (2) to observed compensation data, the expression $\rho c \sigma^2$ appears in a number of recent studies that use linear principal/agent models to study the sensitivity of managerial wealth changes to shareholder wealth changes. Aggarwal and Samwick (1999), for example, offer a model where the optimal share of firm equity held by a CEO is $1/(1 + \rho c \sigma^2_v)$, where $\sigma^2_v$ is the variance of the firm’s market value. Their estimates of $1/(1 + \rho c \sigma^2_v)$ are around 0.015 for the median firm, with a maximum estimate of 0.027. These estimates suggest that $\rho c \sigma^2_v$ is much greater than one. Even if the variance of market value is considerably

\begin{footnote}{28}{To see this, consider the effects of a 0.5 weight on earnings. If $\gamma = 1$, then this is equivalent to paying the manager 50% of the value he creates. If $\gamma = \frac{1}{2}$, then this is equivalent to paying the manager 25% of the value he creates. If timeliness increases but the firm wants to retain the same incentive level, then it can reduce the weight on earnings.}

\end{footnote}
larger than the variance of earnings (in our sample, return variance is approximately 5.4 times earnings variance), these results suggest that Inequality (2) is unlikely to hold.
References


