European Accounting Review
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713696487

Contracting on the Stock Price and Forward-Looking Performance Measures

Online Publication Date: 01 December 2006
To cite this Article: Dikolli, Shane S. and Vaysman, Igor (2006) 'Contracting on the Stock Price and Forward-Looking Performance Measures', European Accounting Review, 15:4, 445 - 464
To link to this article: DOI: 10.1080/09638180601101992
URL: http://dx.doi.org/10.1080/09638180601101992

European Accounting Review
Vol. 15, No. 4, 445–464, 2006

Contracting on the Stock Price and Forward-Looking Performance Measures

SHANE S. DIKOLLI* & IGOR VAYSMAN**

**Duke University, USA and* ***INSEAD, France*

ABSTRACT We examine the use of earnings, forward-looking performance measures and stock prices in managerial compensation. When the firm's owner and its manager have identical time preferences, the stock price is not useful for motivating the manager, as it is a noisy aggregation of a forward-looking measure and future earnings. In contrast, when the owner and the manager have conflicting time preferences, the noisy stock price is useful for contracting. If the manager has no access to banking and cannot trade the firm's shares, the timeliness of the stock price dominates the extra risk imposed by its noise. At the same time, forward-looking performance measures (such as customer satisfaction) can induce a desirable allocation of management effort between the short term and long term more efficiently than the stock price can. Forward-looking performance measures and the stock price are thus not direct substitutes in rewarding farsighted effort.

1. Introduction

Managerial decisions impact the firm's profitability both in the current financial period and in future ones. But what measures are most useful in evaluating these decisions? Accounting profit can provide noisy information about managerial effort that enhances *current* financial performance; however, profit is a poor indicator of managerial effort influencing the firm's *future*. Consequently, employee compensation plans frequently include both annual and long-term cash incentive components.[1] Performance measures that are forward-looking in nature are gaining increasing popularity as one of the bases in these incentive plans; the forward-looking measures are frequently non-financial in nature (examples include

Correspondence Address: Shane S. Dikolli, Duke University, The Fuqua School of Business, Box 90120, Durham, NC, 27708, USA. Tel.: +1 919 660 1949; E-mail: dikolli@duke.edu

0963-8180 Print/1468-4497 Online/06/040445–20
DOI: 10.1080/09638180601101992
Published by Routledge Journals, Taylor & Francis on behalf of the EAA.

customer satisfaction, quality metrics, market share and new-product introductions; see Rucci *et al.*, 1998).

There are two possibilities for providing managers with incentives to expend effort on activities with *future* consequences. When metrics predicting future performance (forward-looking measures) are available, managerial compensation can be based directly on these measures. The other possibility is to base managerial rewards on the firm's stock price, since equilibrium stock prices reflect investor expectations of the firm's future performance. Compensation then indirectly rewards managerial actions to enhance future performance.

The economic consequences of the two compensation alternatives differ among firms, and the conditions under which one form is economically superior to the other are not obvious. The use of both forms of compensation in practice suggests that neither method is unambiguously superior. In addition to the actual out-of-pocket managerial compensation, the firm's compensation committee must consider a number of factors. When basing managerial contracts directly on forward-looking performance measures, important factors are: the cost of producing the measure, its timing, its reliability and specific effects on managerial actions. When basing compensation on the stock price, important considerations include the noise in the stock price and the effect on managerial actions.

Our objective in this paper is to develop insights into the choice between the direct and indirect forms of providing managerial incentives for farsighted effort. To do this, we use a two-task principal–agent model – one of the agent's tasks (*shortsighted* effort) provides benefits to the firm at the end of period 1, while the other task (*farsighted* effort) provides benefits at the end of period 2. In the first period, the firm operates and its first-period profit is reported. At the end of the first period, the principal observes a forward-looking performance measure that captures the agent's farsighted effort with noise. Each investor also privately observes a signal that equals the firm's second-period profit with investor idiosyncratic noise. The principal observes the firm's ensuing stock price and uses it, as well as the period-l profit and the forward-looking measure, to compensate the agent. In the second period, the firm operates and its second-period profit is reported. The principal then compensates the agent for the period-2 profit.

We address the incentive issues in two steps. First, we present the determinants of long-term incentive weights that are based on the profit signals, the stock price and a forward-looking performance measure in the benchmark setting where the principal and the agent are equally patient.[2] We find that the firm optimally includes a positive weight on the forward-looking performance measure but a zero weight on the stock price. Second, we analyze the implications in the setting where the principal is either more or less patient than the agent. We derive closed-form solutions for the optimal weights on the current forward-looking performance measure, the stock price and future profit.

The main contribution of the paper is twofold. First, we show that if the agent does not have the same patience as the principal (i.e. they have conflicting time preferences) and the agent has no access to banking or cannot trade shares in the firm, both a noisy forward-looking performance measure and the stock price are valuable for contracting with respect to farsighted effort. This is true even when the stock price simply adds noise to contractible realizations of interest to the principal (e.g. long-term profits). In particular, even though the stock price is non-informative (in the Holmstrom, 1979, sense) about farsighted effort, contracting on an 'early' stock price generates second-best effort levels at a relatively lower risk premium than a 'late' but informative profit signal.[3] This is because contracting on the stock price helps better align the agent's consumption of utility with his preferences. More generally, the principal can contract on either: (i) a timely stock-price signal (which has risk-reduction benefits because the principal contracts with an impatient agent *now* instead of *later* using the long-term profit); or (ii) a long-term profit signal (which has risk-reduction benefits because it is a more precise measure than the stock price). The preferred performance measure depends on which contracting choice generates the highest risk-reduction benefits, which in turn depends on the agent's time preferences.

Second, an internally generated, noisy, forward-looking performance measure can be more cost-effective in rewarding an agent's farsighted efforts than the stock price, even though the price incorporates investors' private signals of future performance. Intuitively, contracting on the forward-looking measure can induce the agent's farsighted effort at a relatively lower risk premium than does contracting on the stock price. The emphasis on the forward-looking measure is affected by the tradeoff that the principal makes between: (i) the benefits of the earlier timing of the stock price; and (ii) the benefits arising from the period-2 profit signal's informativeness relative to the stock price.[4]

This paper is organized as follows. The next section describes the basic model. In Section 3 we derive the optimal linear incentive weights on the stock price, a forward-looking performance measure and a long-term profit measure when the principal and the agent are equally patient. In Section 4, we derive the relative incentive weights when the principal and the agent have conflicting time preferences. Section 5 concludes.

2. Basic Model

A risk-neutral board of directors (the principal) hires a risk- and effort-averse manager (agent) to operate a firm over two periods. The agent's personally-costly effort choices are not contractible. The agent chooses the levels of shortsighted effort a and farsighted effort b in the first period. The shortsighted effort represents actions that affect the firm's profit in the first period; examples include attracting new customers, exerting pressure on existing customers and offering discretionary discounts. The farsighted effort affects the second period's profit; this effort represents any activities that improve the firm's expected future profitability (examples include brand marketing efforts, customer-satisfaction surveys and quality-improvement investments).

The firm's profit in period 1, π_1, is a function of the agent's shortsighted effort, a, and a random shock, $\tilde{\varepsilon}_1$, where $\tilde{\varepsilon}_1 \sim N(0, \sigma_1^2)$:[5]

$$\tilde{\pi}_1 = a + \tilde{\varepsilon}_1. \tag{1}$$

Period-2 profit is a function of the agent's farsighted effort, b, and a transient shock, $\tilde{\varepsilon}_2$, where $\tilde{\varepsilon}_2 \sim N(0, \sigma_2^2)$:

$$\tilde{\pi}_2 = b + \tilde{\varepsilon}_2. \tag{2}$$

The agent's cost of effort is a twice-differentiable convex function of a and b:

$$C(a,b) = \frac{a^2}{2} + \frac{b^2}{2}. \tag{3}$$

The agent exerts both shortsighted and farsighted effort to maximize his expected utility. We allow the principal's and the agent's time preferences to differ: the variable δ represents the discount factor that the agent uses to assess future utility, and the principal's discount factor is normalized to 1. Thus, the effect of $\delta < 1$ ($\delta > 1$) is that the agent is less (more) patient than the principal.[6] We also assume the agent is unable to smooth consumption over time through borrowing or lending. Accordingly, an important implication of conflicting time preferences is that the principal needs to be concerned with smoothing the agent's consumption over time.

The agent's utility reflects constant absolute risk aversion at a single point in time, so that:

$$U(\cdot) = 1 - \mathrm{e}^{-r(\tilde{w}_1 + \delta\tilde{w}_2 - C(a,b))}. \tag{4}$$

The variable w_i represents the wage paid to the agent in period $i \in \{1,2\}$. The variable r is the Arrow–Pratt measure of absolute risk aversion.

The firm's market price, m, is influenced by the release of public information about profit performance. In the basic model there is no investor private-information gathering, so no trade occurs in the marketplace. Additionally, the agent is not permitted to trade in the firm's shares.[7] The release of public information moves the price without altering the incentives to trade. That is, price changes but investors remain equally happy with their asset allocations.

The principal observes a forward-looking performance measure at the end of period 1, which captures with error the impact of (unobservable) period-1 farsighted effort. This measure is

$$\tilde{y} = b + \tilde{\varepsilon}_y, \tag{5}$$

with $\varepsilon_y \sim N(0, \sigma_y^2)$. This forward-looking signal, a period-1 performance measure, is correlated with period-2 profit because period-2 profit is a linear function of farsighted effort. Market participants know the structure of the firm's compensation. Accordingly, the market can conjecture the contracting value of the forward-looking signal. But the forward-looking signal is not included in the firm's publicly released accounting report, and investors do not directly observe the realization of the forward-looking signal (this is consistent with the idea that firms use forward-looking signals to manage the firm but do not publicly disclose these signals, see Rucci *et al.*, 1998).

The correlation of a future profit measure and a current performance measure that is not part of the firm's publicly released accounting report (such as the forward-looking signal) is consistent with empirical evidence reported in Hayes and Schaefer (2000). One of their findings is that unexplained variation in current executive compensation is correlated with future financial performance. This finding is consistent with the explanation that firms contract with executives on current performance measures – unobservable to outsiders of the firm – that are linked to the firm's future financial performance.[8]

The sequence of events is as follows. Before period 1, the principal specifies the agent's compensation contract. The agent's compensation in each period comprises a fixed salary plus incentive weights on contractible performance signals such as the firm's profit, the stock price and the forward-looking performance measure. The agent chooses shortsighted and farsighted effort levels. During period 1, the firm sells goods or services. At the end of period 1 the principal measures performance and observes the firm's market price. The principal then uses the appropriate performance signals to reward the agent. In period 2, the firm sells goods or services. At the end of period 2, the principal measures profit and pays the agent a fixed salary plus an incentive component.

3. Benchmark Analysis: Incentives when the Principal and Agent are Equally Patient

The purpose of this section is to generate a benchmark result consistent with prior findings. Both Paul (1992) and Feltham and Xie (1994) show that an incentive contract that can include both the firm's profit and its stock price will optimally place zero weight on the stock price. Intuitively, this result is due to noise traders. If it is feasible to contract directly on a publicly released profit signal, then the principal finds contracting directly on the profit signal more efficient than contracting on a stock-price signal of performance that responds to both the profit signal and the actions of noise traders.

The analysis proceeds as follows. First, we restrict the analysis to where the principal and agent have the same time preferences by setting $\delta = 1$.[9] This is similar to Paul's (1992) and Feltham and Xie's (1994) multi-task, multiple measure settings, but we add here the ingredients of a forward-looking performance measure and a rational expectations equilibrium in which the stock price impounds both a publicly disclosed profit signal and investors' private information.[10]

Second, we describe the structure of the agent's reward system, with profit signals, forward-looking performance signals, and the firm's stock price available for contracting. Third, by maximizing the agent's certainty equivalent, we establish the determinants of the agent's effort levels. Fourth, we solve the principal's optimization problem and discuss the economic intuition and implications for management accounting. Overall, the results of the benchmark analysis are consistent with the findings of Paul (1992) and Feltham and Xie (1994) in that they show conditions under which there is no contracting demand for stock price.

Recall that at the beginning of period 1 the principal announces the agent's reward systems for both periods. The reward system for period 1 consists of a fixed salary component, α; a component based on a profit signal, π_1; a component based on the forward-looking signal, y; and a component based on the firm's market price, m. The agent's wage in period 1 is:[11]

$$\tilde{w}_1 = \dot{\alpha}_1 + \dot{\beta}_1 \tilde{\pi}_1 + \dot{\gamma}\tilde{y} + \dot{\theta}\tilde{m}. \tag{6}$$

With contractible π_2, period-2 compensation need not depend on the market price.

Accordingly, the agent's wage in period 2 is a fixed salary plus an incentive component based only on the profit signal for period 2:[12]

$$\tilde{w}_2 = \alpha_2 + \beta_2 \tilde{\pi}_2. \tag{7}$$

The firm's market price, m, is influenced by the release of public information about profit performance. Consistent with Bushman and Indjejikian (1993) and Kim and Suh (1993), the market price is also influenced by investors acquiring private value-relevant information – in this study the privately gathered information is forward-looking information about the firm's period-2 profit and, thus, about the agent's farsighted effort. Examples of the type of forward-looking information gathered by investors include analyst forecasts of future profits, news releases from the firm, actions of suppliers, customers and competitors, mutual fund manager reports, and qualitative information about the firm observed by market participants.

Specifically, each investor j independently receives the following signal about the firm's period-2 profit:

$$\tilde{\pi}_{Gj} = \tilde{\pi}_2 + \tilde{\varepsilon}_{Gj}, \tag{8}$$

with idiosyncratic errors $\varepsilon_{Gj} \sim N(0, \sigma^2_{Gj})$. The firm's market price is determined by the exchange of the firm's shares. The market price is affected by non-output-related events, z, that have a random component $\varepsilon_z \sim N(0, \sigma^2_z)$. These non-output-related events affect the supply of the firm's shares; they represent the actions of noise traders who exchange shares for liquidity or other exogenous purposes, determined outside the capital market. For example, trades could result from an exogenous demand for a market participant to invest in projects or reduce debt outside of the capital market. Noise trades could also represent exogenous demand for a market participant to manage short-term corporate earnings through realized gains or losses on the sale of the risky asset.

The market price in this setting can be determined in two steps. First, we compute a general representation of the price. Second, the rational market price equilibrium is characterized by solving for coefficients consistent with investor beliefs. At the end of period 1, the general representation of the market price, determined in a linear noisy rational expectations equilibrium, represents the market conjecture of how the price reflects information gathered privately by investors, and the conjecture is self-fulfilling. Following Kim and Suh (1993), we assume the market conjecture is

$$\begin{aligned}\tilde{m} &= d_0 + d_1\tilde{\pi}_1 + d_G\left\{\lim_{J\to\infty}\left(\frac{1}{J}\sum_{j=1}^{J}\tilde{\pi}_{G_j}\right)\right\} + d_y\tilde{y} + d_z\tilde{z} \\ &= d_0 + d_1\tilde{\pi}_1 + d_G\tilde{\pi}_2 + d_y\tilde{y} + d_z\tilde{z}, \qquad (9)\end{aligned}$$

where d_k, $k \in \{1, G, y, z\}$, reflect the intensity with which profit signals and non-output-related events impact the market price (the second equality in (9) follows from the law of large numbers and the assumption that the $\tilde{\varepsilon}_{Gj}$'s are independent). A *normalized* price signal can be defined as

$$\tilde{n} = \frac{1}{d_G}(\tilde{m} - d_0 - d_1\tilde{\pi}_1 - d_y\tilde{y}) = \tilde{\pi}_2 + \frac{d_z}{d_G}\tilde{z}. \qquad (10)$$

The signal n represents the pure incremental knowledge available from observing price, beyond the knowledge available from other sources of information (e.g. profits). We use this normalized price signal in the derivation of the rational expectations equilibrium market price and in the calculation of the optimal incentive contract weights. Using (6), (9) and (10) it is possible to rewrite the manager's wage as

$$\begin{aligned}\tilde{w}_1 &= \dot{\alpha}_1 + \dot{\beta}_1\tilde{\pi}_1 + \dot{\gamma}\tilde{y} + \dot{\theta}\tilde{m} \\ &= \dot{\alpha}_1 + \dot{\theta}d_0 + (\dot{\beta}_1 + d_1\dot{\theta})\tilde{\pi}_1 + (\dot{\gamma} + d_y\dot{\theta})\tilde{y} + d_G\dot{\theta}\tilde{n} \\ &= \alpha_1 + \beta_1\tilde{\pi}_1 + \gamma\tilde{y} + \theta\tilde{n}, \qquad (11)\end{aligned}$$

where $\alpha_1 \equiv \dot{\alpha}_1 + \dot{\theta}d_0$; $\beta_1 \equiv \dot{\beta}_1 + d_1\dot{\theta}$; $\gamma \equiv \dot{\gamma} + d_y\dot{\theta}$; $\theta \equiv d_G\dot{\theta}$.

The privately gathered signals are idiosyncratic with the variance $(\sigma_2^2 + \sigma_G^2)$, so that the public information is not sufficient for the private information.[13] It then follows from the law of large numbers and the assumption that each of the ε_{Gj}'s is independent that *in aggregate* the period-2 profit will be fully revealed via the firm's stock price, as per equation (9) (see Bushman and Indjejikian, 1993, for a similar argument). This leads to Lemma 1.

Lemma 1. *When the stock price, a forward-looking performance signal and a profit signal are all available for contracting, the competitive equilibrium market price*, $\tilde{m}$, *is characterized by the following coefficients:*

$$\begin{aligned} d_0 &= \hat{\pi}_2(1-\beta_2) - (\alpha_1 + \alpha_2); \\ d_1 &= 1 - \beta_1; \\ d_y &= \gamma; \\ \frac{d_z}{d_G} &= \frac{\sigma_G^2}{R}. \end{aligned} \tag{12}$$

where R *is the investors' risk aversion parameter and* $\hat{\pi}_2$ *is the conditional expectation of the period-2 profit.*

Proof. See Appendix for all proofs.

Intuitively, the price coefficient on the period-1 profit will be 1 less the share of profit paid to the agent, because the actual realization of the period-1 profit (net of wages) is known and released to the market. The price coefficient on the forward-looking signal will in equilibrium be the contractual weight on the forward-looking measure. This is because the forward-looking measurement error term is statistically uncorrelated to the stochastic components of the period-1 and period-2 profits.

Intuitively, this means that while the forward-looking signal is incrementally informative about farsighted effort, it is not incrementally informative about the random components in the period-1 and period-2 profits. Thus, the forward-looking signal is only useful for contracting on farsighted effort directly and not via a noisy representation of the forward-looking signal in the stock price.

With normally distributed uncertainty and negative exponential utility, the agent's problem is to maximize the certainty equivalent of the expected utility (see Holmstrom and Milgrom, 1987). In this case, the certainty equivalent (CE) is the mean value of the wage less the risk premium. The risk premium is computed by substituting (10) into (11), adding the result to (7), and calculating var $(\tilde{w}_1 + \tilde{w}_2)$. This gives[14]

$$\mathrm{var}(\tilde{w}_1 + \tilde{w}_2) = \beta_1^2\sigma_1^2 + (\theta + \beta_2)^2\sigma_2^2 + \left(\frac{d_z}{d_G}\right)^2 \theta^2\sigma_z^2 + \gamma^2\sigma_y^2. \tag{13}$$

The certainty equivalent then equals:

$$\mathrm{CE} = (\alpha_1 + \alpha_2) + (\beta_1 \bar{\pi}_1 + \beta_2 \bar{\pi}_2) + \gamma E[y] + \theta E[n] - \left(\frac{a^2 + b^2}{2}\right) - \frac{r}{2}\left(\beta_1^2 \sigma_1^2 + (\theta + \beta_2)^2 \sigma_2^2 + \left(\frac{d_z}{d_G}\right)^2 \theta^2 \sigma_z^2 + \gamma^2 \sigma_y^2\right), \quad (14)$$

where $\bar{\pi}_1$ and $\bar{\pi}_2$ represent the mean values of profit in periods 1 and 2, respectively. Substituting equations (1), (2), (5) and (10) into (14) and differentiating with respect to shortsighted and farsighted effort yields the optimal effort choices by the agent:

$$a^* = \beta_1. \quad (15)$$

$$b^* = \theta + \gamma + \beta_2. \quad (16)$$

Intuitively, the principal can use three different instruments to induce farsighted effort; these are the weights on: (i) period-2 profit; (ii) the forward-looking measure at the end of period 1; and (iii) the incremental information contained in the (filtered) stock price at the end of period 1. To ensure the agent accepts the incentive contract, the principal must meet the agent's reservation utility in each period, which we normalize to zero. The individual rationality constraint is

$$E[\tilde{w}_1] + E[\tilde{w}_2] = \left(\frac{a^2}{2}\right) + \left(\frac{b^2}{2}\right) + \frac{r}{2}(\mathrm{var}(\tilde{w}_1 + \tilde{w}_2)). \quad (17)$$

The principal's problem is to maximize profit subject to the agent's incentive compatibility constraint, the agent's individual rationality constraint and the rational market price. The optimization program is

$$\underset{\beta_1, \beta_2, \theta, \gamma}{\mathrm{Max}}\; E[\tilde{\pi}_1 + \tilde{\pi}_2 - \tilde{w}_1 - \tilde{w}_2]$$

subject to:

$$E[\tilde{w}_1] + E[\tilde{w}_2] = \left(\frac{a^2}{2}\right) + \left(\frac{b^2}{2}\right) + \frac{r}{2}\left(\sum_{i=1}^{2}(\beta_i^2 \sigma_i^2) + \gamma^2 \sigma_y^2 + \theta^2 \sigma_n^2\right);$$

$$a^* = \beta_1;$$

$$b^* = \gamma + \beta_2 + \theta;$$

$$E[\tilde{m}] = d_0 + d_1 E[\tilde{\pi}_1] + d_G E[\tilde{\pi}_2] + d_y E[\tilde{y}] + d_z E[\tilde{z}].$$

This leads to the following result.

Proposition 1. *When the stock price, a forward-looking performance measure and profit signals are all available for contracting, the optimal linear incentive weights are*

$$\beta_1^* = \frac{1}{1 + r\sigma_1^2}; \tag{18}$$

$$\beta_2^* = \frac{\sigma_y^2}{\sigma_y^2 + \sigma_2^2\left(1 + r\sigma_y^2\right)}; \tag{19}$$

$$\gamma^* = \frac{\sigma_2^2}{\sigma_y^2 + \sigma_2^2\left(1 + r\sigma_y^2\right)}; \tag{20}$$

$$\theta^* = 0. \tag{21}$$

The results in Proposition 1 are consistent with prior work. For example, the forward-looking measure and the period-2 profit signal act as substitutes in rewarding farsighted effort – the rate of substitution depends directly on the relative noise in the signals (consistent with Banker and Datar, 1989). Additionally, the stock price has no contracting role (consistent with Paul, 1992; Feltham and Xie, 1994). Intuitively, the stock price does not contain any relevant information that the principal does not already observe in the profit signals and the forward-looking performance measure. The stock price is therefore not relevant for contracting purposes (consistent with Holmstrom, 1979), and the principal is better off contracting on the forward-looking measure (in period 1) and profit signals (in each period) directly.

We now turn our attention to a setting where the agent is more or less patient than the principal. This may make it efficient to use a relatively noisy forward-looking measure or stock price *now*, rather than wait until a profit signal is realized in the *future*. We also consider the interactions between the optimal long-term incentive weights on the stock price and on the forward-looking signal.

4. Incentives when the Principal and the Agent have Conflicting Time Preferences

A principal and an agent can have conflicting time preferences for numerous reasons. Most likely, the principal is more patient than the agent. The agent may be close to retirement or simply be averse to deferred compensation. A younger agent may have low employee loyalty and expect to 'job-hop' in search of better employment opportunities. Even a loyal employee, as part of a career development program, may be expecting to rotate into another division of the firm and not benefit from future consequences of his current actions. An agent may also myopically focus on short-term objectives to meet or beat analysts' forecasts (for research documenting this phenomenon see, for example, Matsumoto, 2002). While less likely, the *agent* may alternatively be *more patient than the principal.* For example, the agent may make choices to enhance a long-term career with the firm or to cultivate firm-specific human resource skills while the principal is represented on average by short-term investors that seek to maximize short-term returns.

We operationalize the idea that the principal and agent have conflicting time preferences with $\delta \neq 1$. We then solve the optimal linear compensation program as before and identify conditions under which the forward-looking property of the stock price creates a contracting role for the price, even when a current forward-looking signal of performance and a long-term measure of performance are both available for contracting purposes.

We proceed as follows. The solution of the rational expectations market equilibrium does not depend on δ; thus, even when $\delta \neq 1$, the equilibrium will be the same as in Lemma 1. Next, the agent's certainty equivalent (CE) is the mean value of the wage less the risk premium, but the mean value of the agent's period-2 wage (including risk premium) is now scaled by δ. This gives

$$\mathrm{CE} = (\alpha_1 + \delta\alpha_2) + \left(\beta_1 \bar{\pi}_1 + \delta\beta_2 \bar{\pi}_2\right) + \gamma E[\tilde{y}] + \theta E[\tilde{n}] - \left(\frac{a^2 + b^2}{2}\right)$$
$$- \frac{r}{2}\left(\beta_1^2\sigma_1^2 + (\theta + \delta\beta_2)^2\sigma_2^2 + \left(\frac{d_z}{d_G}\right)^2 \theta^2\sigma_z^2 + \gamma^2\sigma_y^2\right). \quad (22)$$

Maximizing the agent's certainty equivalent with respect to shortsighted and farsighted effort gives

$$a^* = \beta_1; \quad (23)$$
$$b^* = \theta + \gamma + \delta\beta_2. \quad (24)$$

The structure of the optimal effort levels is familiar from Section 3. The major difference is that the incentive linked to long-term profit, used to induce the agent's farsighted effort in (24), is scaled by δ. Thus, if the principal is more (less) patient than the agent, then the optimal farsighted effort will be lower (higher) relative to the equal-patience case. In other words if the agent has a shorter (longer) horizon than the principal, then the long-term incentive used to induce farsighted effort is optimally reduced (increased) relative to the identical principal and agent horizons' case.

The principal maximizes profit subject to the agent's incentive compatibility constraint, the agent's individual rationality constraint and the rational market price. The optimization program is

$$\operatorname*{Max}_{\beta_1,\beta_2,\theta,\gamma} E[\tilde{\pi}_1 + \tilde{\pi}_2 - \tilde{w}_1 - \tilde{w}_2]$$

subject to:

$$\begin{aligned}
&E[\tilde{w}_1] + \delta E[\tilde{w}_2] = \left(\frac{a^2}{2}\right) + \left(\frac{b^2}{2}\right) + \frac{r}{2}(\mathrm{var}(\tilde{w}_1 + \delta\tilde{w}_2));\\
&E[\tilde{w}_2] = \frac{r}{2}\left(\beta_2^2\sigma_2^2\right);\\
&a^* = \beta_1;\\
&b^* = \gamma + \delta\beta_2 + \theta;\\
&E[\tilde{m}] = d_0 + d_1 E[\tilde{\pi}_1] + d_G E[\tilde{\pi}_2] + d_y E[\tilde{y}] + d_z E[\tilde{z}].
\end{aligned}$$

To be able to substitute the incentive compatibility constraint into the principal's objective function, we restate the objective function as

$$E[\tilde{\pi}_1 + \tilde{\pi}_2 - \tilde{w}_1 - \tilde{w}_2] = E[\tilde{\pi}_1] + E[\tilde{\pi}_2] - E[\tilde{w}_1] - \delta E[\tilde{w}_2] - (1 - \delta)E[\tilde{w}_2]. \tag{25}$$

We then substitute the constraints of the optimization program into (25). Simultaneously solving the first-order conditions for the principal's problem provides the optimal incentive weights on the profit signals, the forward-looking signal and the stock price. While closed-form solutions are obtainable, the expressions contain a complicated denominator that is common in the three incentive weights based on measures of farsighted effort.[15] To streamline the analysis, we thus present the optimal weight on the stock price, *relative* to the weight on the period-2 profit measure and forward-looking signal, respectively, and the weight on the period-2 profit measure relative to the forward-looking signal, in Proposition 2.

Proposition 2. *When the principal and the agent have conflicting time preferences (i.e. $\delta \neq 1$) then the relative incentive weights are as follows:*

$$\frac{\theta^*}{\beta_2^*} = T\sigma_2^2; \tag{26}$$

$$\frac{\theta^*}{\gamma^*} = \frac{\sigma_y^2}{\sigma_2^2 + \dfrac{L}{T}}; \tag{27}$$

$$\frac{\beta_2^*}{\gamma^*} = \frac{\sigma_y^2}{\sigma_2^2\left(T\sigma_2^2 + L\right)}; \tag{28}$$

where

$$T = \frac{1-\delta}{\delta} \cdot \frac{R^2}{(\sigma_G^2)^2 \sigma_z^2} \quad \text{and} \quad L = \frac{(1-\delta+\delta^2)}{\delta}.$$

By substituting in $d_z/d_G = \sigma_G^2/R$ from Lemma 1, the above incentive weights are functions of only exogenous economic parameters, after solving for the firm's rational expectations market equilibrium at the end of period 1. The key insight from Proposition 2 is that, even though the stock price is merely a noisy aggregation of two contractible performance signals, its timeliness relative to the period-2 profit makes the stock price a valuable contracting instrument. This is because contracting on the stock price enables the agent to smooth consumption. The weight on the stock price relative to the weight on period-2 profit depends on the ratio of the precision of the two performance measures, scaled by a timeliness (or consumption smoothing) factor, $(1-\delta)/\delta$. The greater the difference in the principal's and agent's time preferences (e.g. as δ approaches zero), the more important the timeliness of the stock price, and the greater the demand for it as a contracting variable relative to period-2 profit. On the other hand, the more aligned the patience of the principal and the agent (e.g. as δ approaches one), the relative weight on the stock price becomes closer to zero and approaches the benchmark case in Section 3.

Note that the forward-looking measure and the stock price are both available as contracting variables at the same point in time. However, timeliness still affects the relative weight on these two measures because they provide different signals of farsighted effort, with the stock-price measure being affected by: (i) the relative noise in the stock price; and (ii) the timeliness of the stock price relative to the period-2 profit signal. Thus, the weight in (27) on the stock price relative to the forward-looking measure can be characterized by a component related to the relative precision in the 'filtered' signal (the first term in the denominator in (27)) plus a component related to the precision and timeliness of the stock price in capturing the contractible signals (the second term in the denominator in (27)). At an extreme, if time preferences converge (e.g. $\delta \rightarrow 1$) so that timeliness is not an issue, the relative weight in (27) becomes extremely small, implying little role for the stock price relative to the forward-looking measure for contracting purposes.

Finally, the choice between weighting the forward-looking measure and the period-2 profit is directly affected by the presence of a noisy stock price that impounds both measures of performance which, in the case of period-2 profit, is done in a timely manner. At an extreme when the agent is extremely impatient (i.e. $\delta \rightarrow 0$), the period-2 profit becomes increasingly irrelevant relative to the forward-looking measure in directing the agent's attention to the farsighted effort (because the impatient agent cannot be sufficiently motivated by a period-2 profit measure). Thus, as indicated in (28), when $\delta \rightarrow 0$, the relative weight becomes extremely small.

Overall, when the principal and the agent are not equally patient, it is clear that timeliness matters in determining the contracting weights, because of the agent's preference to smooth consumption. If $\delta < 1$, then the stock price becomes a valuable contracting measure because the incentive for farsighted effort is paid at the end of period 1, rather than at the end of period 2. Intuitively, with $\delta < 1$, the agent is more impatient than the principal, and thus prefers the earlier timing of the incentive. The agent is then subjected less to variations in exogenous, risk-imposing parameters associated with the operation of the firm in period 2. Accordingly, the agent faces a tradeoff between the earlier payment of the stock-price incentive and the non-output related noise in the stock-price measure.

Another important implication of Proposition 2 is that a demand exists for a forward-looking measure relative to the stock price, even though: (i) the stock price impounds both trailing and future signals of performance; and (ii) the market conjectures the contracting value of the forward-looking measure. The intuition is based on incremental informativeness (Holmstrom, 1979) in that the forward-looking measure is not a sufficient statistic for the pair of measures (i.e. forward-looking measure and stock price) with respect to farsighted effort. The forward-looking measure more efficiently directs the agent's attention to both shortsighted and farsighted efforts than contracting on the stock price alone. Overall, the results suggest an extension of the informativeness principle (Holmstrom, 1979). The conflicting time preferences imply that while the period-2 profit signal is a sufficient statistic for the stock price in rewarding farsighted effort, the stock price is useful for contracting because it allows the agent to smooth consumption. This has spillover implications for the choice between the weights on the stock price and the current forward-looking performance measure. In summary, the risk-reduction benefits of contracting with an impatient agent *now* using a timely measure such as stock price, instead of *later* using the long-term realization, are weighed against the risk-reduction benefits of using a long-term profit signal instead of either a *potentially* noisier (i.e. a current forward-looking performance measure) or a *directly* noisier contracting variable (i.e. the stock price).

5. Conclusion

The purpose of this paper is to investigate why firms emphasize various contracting variables in setting long-term monetary incentives. We consider three types of long-term contracting variables: a future measure of profit, a current forward-looking measure of performance and the stock price. Consistent with existing theory, the analysis shows that, as long as the principal and the agent have identical time preferences, there is no role for the stock price as a long-term contracting variable. Intuitively, the stock price is not incrementally informative (in the Holmstrom, 1979 sense) about farsighted effort. Further, whether or not a forward-looking signal is available for contracting does *not* impact the contracting role of the stock price.

The stock price becomes useful for contracting if the principal and the agent have conflicting time preferences, and the agent cannot access either banking or capital-market trading. We highlight the tradeoffs between the contractible variables used to provide long-term monetary incentives. In particular, performance measure *timing* directly affects the contracting use of the stock price, the forward-looking performance measure, and the period-2 profit measure. When the principal's and the agent's time preferences differ, the fact that the future profit signal is a sufficient statistic for the pair of signals (the stock price and the period-2 profit) with respect to farsighted effort does not eliminate the contracting value of the stock price. Instead, the more timely stock price allows the agent to smooth consumption in accordance with the agent's preferences and thus becomes useful for contracting purposes.

The results have intuitive implications about the concurrent use of forward-looking signals and the stock price for long-term contracting. In particular, even if a stock price (that impounds signals of future performance) is available for contracting, the forward-looking signal can allow firms to offer:

- More cost-effective monetary incentives. For example, when the stock price is particularly noisy, it may be too costly to use for contracting purposes. If profit signals are similarly cost-prohibitive for contracting, then an emphasis on the forward-looking signal may yield relative savings in risk premium payable by the firm.
- More balance (between short term and long term) in monetary incentives. If profit signals are excessively focused on the short term, then contracting on a forward-looking signal can convince managers to consider long-term implications of their actions.
- More timely monetary incentives. The faster executives are promoted, the less useful are long-term profit signals for rewarding long-term performance, since the executives move on *after* the consequences of their actions generate profits for performance-evaluation purposes. The forward-looking signal allows the firm to reward in the current period executive's actions that ultimately improve long-term profitability. Similarly, even if the current stock price impounds the signal of future profit with noise, the firm may be better off using the stock price to induce farsighted effort instead of waiting until a less noisy long-term profit signal becomes available for contracting.

Acknowledgements

For helpful comments on earlier versions of this paper, we thank Michael Alles, Tony Atkinson, Romana Autrey, Kate Bewley, Phelim Boyle, John Christensen, Wai Fong Chua, Masako Darrough, Alan Douglas, Steve Fortin, Yigal Gerchak, Raffi Indjejikian, Ken Klassen, Kari Lukka, Susan McCracken, Gord Richardson, Bill Scott, two anonymous reviewers, and workshop participants at the

University of Waterloo, Curtin University, the AAA annual meeting, and the AAA Management Accounting Section conference. lgor Vaysman acknowledges funding provided by the INSEAD Alumni Fund.

Notes

[1]Cash-based bonuses have attracted significant recent attention in practice, and firms are moving away from rewarding executives with stock options and toward cash bonuses. A recent survey finds that the percentage of overall bonus-based CEO pay has grown from l3% in 2001 to 19% in 2003 (Fink, 2004). During the same time period, long-term incentives in the form of stock options and restricted stock fell from 71 to 63%.

[2]The principal and the agent are *equally patient* when they have the same preferences over future utility (i.e. they use the same rate to discount future utility).

[3]This is similar to a result in Christensen *et al.* (2005), who show in a different setting, that performance measure timeliness can make a non-informative measure (in the sufficient statistic sense) valuable for contracting purposes.

[4]Feltham and Wu (2000) extends the literature on contractible performance measures by analyzing determinants of the relative weights placed on a publicly available performance measure and a price-based measure in a single-period setting, where investors can affect the price-based measure by acquiring private information at a cost. Their work focuses on how contract weights are affected by the non-congruity of the principal's objective with the performance measures and the non-congruity of the two performance measures with each other. Dutta and Reichelstein (2003) specifically incorporate multi-period issues in their analysis of weights on publicly available, and price-based, performance measures. The present paper includes a forward-looking performance measure unrelated to price or earnings, allows the principal and the agent to have conflicting time preferences, exogenously specifies private information gathering and does not attempt to model performance measure congruity. These modeling choices isolate the value of forward-looking performance measures (in the presence of a stock-price contracting variable) that fundamentally distinguish this paper from both Feltham and Wu (2000) and Dutta and Reichelstein (2003).

[5]An example of the profit signal is the firm's publicly disclosed accounting income measure.

[6]See Hauser *et al.* (1994) and Dikolli (2001) for other work that investigates the effects of different discount factors (i.e. $\delta \neq 1$).

[7]Recent trends in practice indicate that firms are increasingly using restricted stock (e.g. see Gabriel, 2005). For analysis of a setting where the agent trades in the firm's shares, see Baiman and Verrecchia (1995).

[8]In our analysis, the market participants conjecture via the compensation contract, but do not directly observe the value of the forward-looking signal.

[9]We analyze the case of $\delta \neq 1$ in Section 4.

[10]Bushman and Indjejikian (1993) and Kim and Suh (1993) incorporate a rational expectations equilibrium in studying optimal incentive weights when the stock price and earnings are available for contracting. However, the focus in those studies is on the role that contractible earnings play in contracts, rather than on describing the conditions under which there is no contracting demand for the stock price. Those studies also do not consider the possibility that a forward-looking performance measure is available for contracting.

[11]Consistent with a large literature on incentives, we make no claim that linear compensation contracts are optimal. Instead we focus on the optimal linear compensation. For examples, see Feltham and Xie (1994), Datar *et al.* (2001) and Dikolli (2001).

[12]Note that the parameters of the wage contracts are either observable or can be inferred by capital market participants.

[13] σ_G^2 represents the aggregate variance of the idiosyncratic errors in the investors' signals.

[14] Note that the independent distributions imply covariances of zero for the random variables, y, π_i and n.

[15] Not surprisingly, the weight on the period-1 profit measure is identical to the case when $\delta = 1$. We therefore omit discussion of β_1^* in this section.

References

Baiman, S. and Verrecchia, R. E. (1995) Earnings and price-based compensation contracts in the presence of discretionary trading and incomplete contracting, *Journal of Accounting and Economics*, 20(1), pp. 93–121.

Bankar, R. D. and Datar, S. M. (1989) Sensitivity, precision, and linear aggregation of signals for performance evaluation, *Journal of Accounting Research*, 27(1), pp. 21–39.

Bushman, R. M. and Indjejikian, R. J. (1993) Accounting income, stock price, and managerial compensation, *Journal of Accounting an Economics*, l6, pp. 3–23.

Christensen, P. O. *et al.* (2005) Timeliness, accuracy, and relevance in dynamic incentive contracts, Working Paper, University of British Columbia.

Datar, S. M. *et al.* (2001) Balancing performance measures, *Journal of Accounting Research*, 39(1), pp. 75–92.

Dikolli, S. S. (2001) Agent employment horizons and contracting demand for forward-looking performance measures, *Journal of Accounting Research*, 39(3), pp. 467–480.

Dutta, S. and Reichelstein S. (2003) Leading indicator variables, performance measurement and long-term versus short-term contracts, *Journal of Accounting Research*, 41(5), pp. 837–866.

Feltham, G. A. and Wu, M. G. H. (2000) Public reports, information acquisition by investors, and management incentives, *Review Accounting Studies*, 5(2), pp. 155–190.

Feltham, G. A. and Xie, J. (1994) Performance measure congruity and diversity in multi-task principal agent relations, *The Accounting Review*, 69(3), pp. 429–453.

Fink, R. (2004) Cash is back in incentive compensation, but companies are struggling to set the right performance targets, *CFO Magazine*, June, p. 4.

Gabriel, F. P. J. (2005) Exec pay + bonuses down, but restricted stock is on rise: firms use those rewards to tie pay to performance, *Investment News*, p. 3.

Grossman, S. J. and Stiglitz, J. E. (1980) On the impossibility of informationally efficient markets, *American Economic Review*, June, pp. 393–408.

Hauser, J. R. *et al.* (1994) Customer satisfaction incentives, *Marketing Science*, 13(4), pp. 327–350.

Hayes, R. M. and Schaefer, S. (2000) Implicit contracts and the explanatory power of top executive compensation for future performance, *RAND Journal of Economics*, 31(2), pp. 273–293.

Holmstrom, B. (1979) Moral hazard and observability, *The Bell Journal of Economics*, Spring, pp. 74–91.

Holmstrom, B. and Milgrom, P. (1987) Aggregation and linearity in the provision of intertemporal incentives, *Econometrica*, 55(2), pp. 303–328.

Kim, O. and Suh, Y. S. (1993) Incentive efficiency of compensation based on accounting and market performance, *Journal of Accounting and Economics*, 16, pp. 25–23.

Matsumoto, D. A. (2002) Management's incentives to avoid negative earnings surprises, *Accounting Review*, 77(3), p. 483.

Paul, J. M. (1992) On the efficiency of stock-based compensation, *The Review of Financial Studies*, 5(3), pp. 471–502.

Rucci, A. J. *et al.* (1998) The employee–customer–profit chain at Sears, *Harvard Business Review*, 76(1), pp. 82–87.

Appendix: Proofs

Proof of Lemma 1. The structure of the following proof is similar to that found in Kim and Suh (1993, pp. 29–32). In a rational expectations equilibrium, market participants conjecture the relationship between the market price and information held by the participants. The conjecture is self-fulfilling. Assume the conjecture is given by

$$\tilde{m} = d_0 + d_1 \tilde{\pi}_1 + d_G \tilde{\pi}_2 + d_y \tilde{y} + d_z \tilde{z}. \tag{A1}$$

A normalized price signal can be defined as

$$\begin{aligned} \tilde{n} &= \frac{1}{d_G}\left(\tilde{m} - d_0 - d_1 \tilde{\pi}_1 - d_y \tilde{y}\right) \\ &= \tilde{\pi}_2 + D\tilde{z} \end{aligned} \tag{A2}$$

where $D = d_z/d_G$. The signal n represents the pure addition of knowledge due to observing price, beyond what is available from other pieces of information. For convenience, the normalized price signal is used in the calculation of the optimal incentive contract weights. The next step is to define, at the end of period 1, the conditional expectation of the final payoff. This will be the sum of the realized period-1 payoff plus the weighted average of the different sources of information used by the market to infer the period-2 payoff. Accordingly

$$\begin{aligned} \tilde{\Pi} &= \tilde{\pi}_1 - \tilde{w}_1 + E\left[(\tilde{\pi}_2 - \tilde{w}_2)|\tilde{\pi}_{G_j},\tilde{n}\right] \\ &= \tilde{\pi}_1 + \hat{\pi}_2 + \frac{1}{Q}\left(\frac{\tilde{\pi}_{Gj}}{\sigma_G^2} + \frac{\tilde{n}}{D^2\sigma_z^2}\right) \\ &\quad - \left(\alpha_1 + \beta_1 \tilde{\pi}_1 + \theta\tilde{n} + \gamma\tilde{y}\right) - \left(\alpha_2 + \hat{\beta}_2 \hat{\pi}_2\right) \end{aligned} \tag{A3}$$

where

$$\begin{aligned} Q &\equiv \mathrm{var}\left[(\tilde{\pi}_2 - \tilde{w}_2)|\tilde{\pi}_{G_j},\, \tilde{n}\right] \\ &= \frac{1}{\sigma_{G_j}^2} + D^2 \frac{1}{\sigma_z^2} \end{aligned} \tag{A4}$$

and

$$\hat{\pi}_2 = E\left[\tilde{\pi}_2 | \tilde{\pi}_{G_j},\tilde{n}\right]. \tag{A5}$$

The value of Q is calculated using the standard derivation for the variance of a random variable conditional on observed signals (cf. Grossman and Stiglitz, 1980, Appendix A). Given two observed signals, it is necessary to compute the determinant of a 3 × 3 matrix, divided by the determinant of a 2 × 2 matrix to derive the value of Q specified in expression (A4).

The investors are assumed to exhibit constant absolute risk aversion and their expected utility is given by

$$E[I] = -\exp\left(-\frac{W}{R}\right) \tag{A6}$$

where R is the investors' risk tolerance. Using the moment-generating function of a normal random variable, the investors' expected utility conditional on the observed information signals is

$$\begin{aligned} E\big[I|\tilde{\pi}_{G_j}, \tilde{n}\big] &= E\left[-\exp\left(-\frac{\tilde{m}}{R} - (\tilde{\pi}_1 + \tilde{\pi}_2 - \tilde{m})\frac{Z_j}{R}\right)|\tilde{\pi}_{G_j}, \tilde{n}\right] \\ &= -\exp\left(-\frac{\tilde{m}}{R} - \left(\tilde{\pi}_1 + \left(E\big[\tilde{\pi}_2|\tilde{\pi}_{G_j}, \tilde{n}\big] - \tilde{m}\right)\right)\frac{Z_j}{R} \right. \\ &\quad \left. + \frac{1}{2Q}\left(\frac{Z_j}{R}\right)^2\right). \end{aligned} \tag{A7}$$

The first-order condition that maximizes utility, with respect to the demand for shares, Z_j, is

$$\begin{aligned} \tilde{Z}_j = RQ\bigg[&\tilde{\pi}_1 + \hat{\pi}_2 + \frac{1}{Q}\left(\frac{\tilde{\pi}_{G_j}}{\sigma_G^2} + \frac{\tilde{n}}{D^2\sigma_z^2}\right) \\ &-(\alpha_1 + \beta_1\tilde{\pi}_1 + \theta\tilde{n} + \gamma\tilde{y}) - (\alpha_2 + \hat{\beta}_2\hat{\pi}_2) - \tilde{m}\bigg]. \end{aligned} \tag{A8}$$

Aggregating over j and applying a zero excess demand condition leads to

$$\begin{aligned} \tilde{m} = \tilde{\pi}_1 + \hat{\pi}_2 &+ \frac{1}{Q}\left(\frac{\tilde{\pi}_2}{\sigma_G^2} + \frac{\tilde{n}}{D^2\sigma_z^2}\right) \\ &- \left(\alpha_1 + \beta_1\tilde{\pi}_1 + \theta\tilde{n} + \gamma\tilde{y}\right) - \left(\alpha_2 + \hat{\beta}_2\hat{\pi}_2\right) + \frac{\tilde{z}}{RQ}. \end{aligned} \tag{A9}$$

Since the initial conjecture by the market participants must be self-fulfilling, (A1) and (A9) are equivalent in equilibrium. Thus

$$D \equiv \frac{d_z}{d_G} = \frac{1/(QD\sigma_z^2) - \theta D + 1/(RQ)}{1/(Q\sigma_G^2) + 1/(QD^2\sigma_z^2) - \theta} \tag{A10}$$

$$\Rightarrow \frac{d_z}{d_G} = \frac{\sigma_G^2}{R}.$$

It follows that

$$\begin{aligned} d_0 &= (1-\beta_2)\hat{\pi}_2 - \alpha_2 - \alpha_1 \\ d_1 &= 1 - \beta_1 \\ d_y &= \gamma \\ \frac{d_z}{d_G} &= \frac{\sigma_G^2}{R}. \end{aligned} \tag{A11}$$

Proof of Proposition 1. Solve the principal's optimization problem by substituting the constraint expressions into the principal's objective function and then take first-order derivatives of the objective function. Simultaneously solve these expressions for the principal's choice variables, that is, the incentive weights on the different performance measures. Simplifying the expressions gives the optimal weights presented in Proposition 1.

Proof of Proposition 2. Solve the principal's optimization problem by substituting the constraint expressions into the principal's objective function and then take first-order derivatives of the objective function. Simultaneously solve these expressions for the principal's choice variables, that is, the incentive weights on the different performance measures. Simplifying the expressions gives the optimal weights presented in Proposition 2.