A Behavioral Explanation of the Relative Performance Evaluation Puzzle

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Abstract

We study the effects of competitive preferences, where Chief Executive Officers (CEOs) compare their wage to the wage of other CEOs within the same industry, and derive utility from being ahead of them. We show that such social concerns work in the direction of CEO wages being positively correlated, in contrast to the Relative Performance Evaluation hypothesis, but consistent with several empirical studies.

1 Introduction

A large recent literature attempts to test the basic hypotheses from agency theory. One strand of this literature has tested a corollary of the Informativeness Principle[1] known as the Relative Performance Evaluation (RPE) hypothesis. The idea behind the RPE hypothesis is that if firms in the same industry face some common random shock, like changes in industry demand, an optimal compensation contract for a CEO makes the payment conditional on the relative performance of the firm (in addition to its absolute

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[1]The Informativeness Principle (Holmström, 1982) states that an optimal contract should condition pay on any variable that is (incrementally) informative about the agent's actions.

performance); the higher the profit of the other firms, the lower the reward of the CEO (see Prendergast, 1999, and Gibbons and Waldman, 1999). The "fine" associated with a higher performance by others eliminates the impact of factors that are unrelated to the agent's effort from the incentive scheme. In the empirical literature, researchers tend to be puzzled by the lack of evidence for RPE in the CEO compensation data. For example, Aggarwal and Samwick (1999a) note that "relative performance evaluation considerations are not incorporated into executive compensation contracts" (page 104). And, Murphy (1999, page 40) states that ".. the paucity of RPE in options and other components of executive compensation remains a puzzle worth understanding".

The purpose of the present paper is to put forward a behavioral explanation for the RPE Puzzle. We rely on the human tendency to compare outcomes with other individuals, and to derive additional utility from out performing others. Several economists have incorporated such social concerns in their analysis of wage and consumption data (Duesenberry, 1949, Easterlin, 1974, and Frank, 1985). There is also some empirical and experimental evidence for the relevance of relative payoff (Clark and Oswald, 1996, Zizzo and Oswald, 2001). The general idea of the paper is that if CEOs care not only about their own wage, but also about the comparison with the wages of other CEOs, then the incentive scheme that firms provide to their manager will depend on the performance of the managers who are included in their manager's reference group.

To study the impact of such status concerns on managerial compensation, we use a simple principal agent framework in which firms consist of one risk averse manager (the CEO) and a risk neutral principal. The manager's effort is unobserved and wages are paid based on their output, which is a noisy measure of their effort. The output of a firm depends on managerial effort, and its profits are independent of the output of the other firms in the industry. However, each CEO's utility may depend on the wage of the other CEOs in the same industry.

Our main finding is that conditioning the wage positively on the other managers' output reduces the effort exerted by these managers and also provides insurance against the added risk generated by the random shocks to the salary of other managers. This result is in contrast to comparative payments based on a positive correlation in the random shocks, where wages depend negatively on the output of other managers, but consistent with empirical evidence that finds little evidence of RPE in the compensation data. More precisely, we show that the effects of competitive preferences work in the opposite direction on compensation schemes as the RPE effect, and hence may explain the lack of RPE effects in compensation data.[2]

Other specifications of social preferences, such as fairness and reciprocity may lead to similar results to the ones we obtain here. Our companion paper, Fershtman et. al. (2002), discusses the relation between competitive preferences and these other forms of social preferences in more detail.[3]

2 The Model

Consider an economy with a large number of firms. The economy is split into n competitive 'industries', where each industry consists of two firms. Firms are run by managers and we assume that there are fewer managers than firms. Firms offer potential managers a wage contract and managers choose in which firm to work depending on the contracts offered by the firms. There is a free mobility of managers between firms and no entry or exit costs for firms.

The output of a manager, denoted by y_i, depends only on his own actions. We let $y_i = e_i + \varepsilon_i$; where e_i denotes his effort, and ε_i is an *iid* random shock, normally distributed with $E(\varepsilon_i) = 0$ and $E(\varepsilon_i^2) = \sigma^2$. Each firm's output is equal to its manager's output. We let $v(e_i) = e_i^2/2$ be the cost of effort for the manager.

Firms do not observe managerial effort and thus contracts may depend only on the realized output of the two managers in the industry. Consider two firms in the same industry denoted by i and j offering wages w_i and w_j, respectively. We assume that managers have competitive preferences and they care not only about their own wage, but

[2]Aggarwal and Samwick (1999b) argue that principals will design managerial incentive contracts to dampen competition in product markets, and may therefore condition a manager's wage positively on the wage of the other managers in the industry. Hvide (2002) argues that relative performance components, i.e., bonuses that depend on market share, will induce a high managerial risk taking, and a low level of effort, and hence may not be included in an optimal incentive scheme. Fershtman et al. (2002) consider the implications of competitive concerns on the organization of work in firms.

[3]Recent surveys on the experimental and theoretical literature on reciprocity are Fehr and Schmidt (2000) and Sobel (2001). Charness and Rabin (2001) attempt to identify experimentally the separate roles of reciprocity, fairness and inequality aversion.

also about the difference in wage from the other manager in the same industry. Their utility function is assumed to be

$$U_i(w_i, w_j, e_i; \beta) = -\mathrm{e}^{-\alpha x_i}, i = 1, 2, \tag{1}$$

where α is the risk aversion parameter and

$$x_i = w_i + \beta(w_i - w_j) - e_i^2/2. \tag{2}$$

Assuming further that ε_i is normally distributed, one obtains a certainty equivalent, whereby the expected utility $E(U_i(x_i))$ is monotone increasing in $E(x_i) - \dfrac{\alpha\sigma_{x_i}^2}{2}$.

The term $(w_i - w_j)$ can be seen as a measure of the status of manager i, while β is a measure of the intensity of manager i's competitive (or status) preferences.[4] The linear specification of competitive preferences, whereby manager i gains utility from being ahead of manager j at a constant rate, β, is quite restrictive and adopted mainly for simplicity. In general, one would expect competition to be more intense when the wage difference between the two managers is small. The term "industry" in our model serves only as a point of reference for status comparisons that influence the managerial compensation offered by firms. The assumption that the outputs of the managers of the two firms are independent is also restrictive but allows us to highlight the role of social interactions. That is, wages may depend on output of the other firm in the industry because the relative wage is important for managers.[5]

We assume linear contracts of the form,

$$w_i(y_i, y_j) = s_i + a_i y_i + b_i y_j. \tag{3}$$

[4] We do not associate any moral value to the attribute of "being competitive". In particular having such preferences implies, among other, the willingness to suffer a reduction of income providing that others will have an even greater reduction. Indeed, Zizzo and Oswald (2001) found that around 65% of respondents agreed to sacrifice 25 cents of their own income to reduce the income of their peers by $1.

[5] Fershtman et al. (2002) discuss an alternative specification, where the reference is other workers in the same firm. That specification involves "local status" within firms, which the firm can influence through creating contract asymmetry and wage inequality. De la Croix (1994) surveys the role of wage comparisons and interdependent preferences in the context of union bargaining.

Given the wage scheme, manager i chooses the effort level,

$$e_i^{opt} = \max(a_i + \beta(a_i - b_j), 0). \tag{4}$$

The term b_j enters manager $i's$ effort decision since by changing his effort manager i affects the wage of manager j. Given his competitive preferences, manager i would prefer that manager j receive lower wages.

Given this wage contract, $\sigma_{x_i}^2$ is given by

$$\sigma_{x_i}^2 = \sigma^2[(a_i(1 + \beta) - \beta b_j)^2 + (b_i(1 + \beta) - a_j\beta)^2], \tag{5}$$

which is independent of the effort levels. The first term in (5) represents the variability of the utility of manager i resulting from the variability of his own output, and the second term represents the variability of the utility of manager i resulting from the variability of the output of the other manager.

If binding contracts on effort and wages could be enforced, the firm would provide perfect insurance and managers would agree to provide the first best level of effort, as under risk neutrality. However, because effort is not contractible, the optimal contract maximizes expected utility with respect to the contractual parameters. Thus, we obtain a second best contract that trades off the incentive for effort against the need for insurance.

Firms are assumed to be risk neutral and their expected profits are given by their expected output minus the expected wage they provide to their manager, i.e.,

$$E(\pi_i) = e_i(1 - a_i) - e_j b_i - s_i. \tag{6}$$

Firms compete for managers by offering contracts that specify (s_i, a_i, b_i).

Equilibrium in this model consists of wage contracts $w_i^*(y_i, y_j)$, $w_j^*(y_i, y_j)$ and effort levels e_i^* and e_j^* such that

1. The wage contracts $w_i^*(y_i, y_j)$, $w_j^*(y_i, y_j)$ are a Nash equilibrium between the two firms in each industry.
2. Managers cannot benefit from moving to another firm and accepting its contract.
3. Potential entrants cannot offer a contract that may attract managers and gain

positive profits.

3 Equilibrium wages and incentives

Due to the interdependence of preferences, we must solve for an equilibrium that determines simultaneously the contracts offered by the two firms in each industry.

Firm i solves the following problem

$$\begin{aligned} & \max_{a_i,b_i,s_i} E(\pi_i) \qquad (7) \\ s.t. \quad E(U_i) &\geq U_{0i}, \\ e_i^{opt} &= \max(a_i + \beta(a_i - b_j), 0), \\ e_j^{opt} &= \max(a_j + \beta(a_j - b_i), 0). \end{aligned}$$

where U_{0i} is the reservation utility of manager i. The principal of firm i takes the contract of manager j, i.e., (a_j, b_j, s_j) as given. Firm j solves the mirror image of firm i's problem, with j replacing i, and takes (a_i, b_i, s_i) as given.

Because the moment generating function of the Normal Distribution has the form

$$E(e^{tx}) = \exp\{\mu t + \frac{1}{2}\sigma^2 t^2\}, \qquad (8)$$

we can choose $t = -\alpha$, set $U_{0i} = -e^{-\alpha r_i}$, and rewrite the program as

$$\begin{aligned} & \underset{a_i,b_i,s_i}{Max} E(\pi_i) = e_i(1 - a_i) - b_i e_j - s_i, \qquad (9) \\ & s.t. \quad E(x_i) - \frac{\alpha \sigma_{x_i}^2}{2} \geq r_i, \\ E(x_i) &= (1 + \beta)(a_i e_i + b_i e_j + s_i) - \beta(a_j e_j + b_j e_i + s_j) - e_i^2/2, \\ e_i &= \max(a_i + \beta(a_i - b_j), 0), \\ e_j &= \max(a_j + \beta(a_j - b_i), 0), \\ \sigma_{x_i}^2 &= \sigma^2[(a_i(1 + \beta) - \beta b_j)^2 + (b_i(1 + \beta) - a_j \beta)^2]. \end{aligned}$$

In the optimum, the participation constraint must hold as an equality. We can thus solve for s_i from the participation constraint and substitute it into the firm's expected profit so that the maximization problem of the firm becomes

$$\begin{aligned}
\underset{a_i,b_i}{Max} V_i &= (1+\beta)e_i - \beta(s_j + a_j e_j + b_j e_i) - \frac{1}{2}e_i^2 \\
&\quad -\frac{\alpha}{2}\sigma^2[(a_i(1+\beta) - \beta b_j)^2 + (b_i(1+\beta) - a_j\beta)^2] - r_i \\
&\quad s.t. \\
e_i &= Max\{a_i + \beta(a_i - b_j), 0\}, \\
e_j &= Max\{a_j + \beta(a_j - b_i), 0\}.
\end{aligned} \tag{10}$$

where $V_i \equiv (1+\beta)E(\pi)$. In an interior solution with $e_i, e_j > 0$, we can differentiate with respect to a_i and b_i and obtain,

$$\frac{\partial V_i}{\partial a_i} = [(1+\beta) - \beta b_j - e_i]\frac{\partial e_i}{\partial a_i} - \alpha\sigma^2(1+\beta)(a_i(1+\beta) - \beta b_j). \tag{11}$$

$$\frac{\partial V_i}{\partial b_i} = -a_j\beta\frac{\partial e_j}{\partial b_i} - \alpha\sigma^2(1+\beta)(b_i(1+\beta) - a_j\beta). \tag{12}$$

Substituting $\frac{\partial e_i}{\partial a_i} = 1+\beta$, $\frac{\partial e_j}{\partial b_i} = -\beta$ and $e_i = e_i^{opt}$ we obtain,

$$\begin{aligned}
\frac{\partial V_i}{\partial a_i}\frac{1}{1+\beta} &= (1+\beta) - \beta b_j - (a_i + \beta(a_i - b_j)) - \alpha\sigma^2(a_i(1+\beta) - \beta b_j) \\
&= 1 + \beta + \alpha\sigma^2\beta b_j - a_i(1+\beta)(1+\alpha\sigma^2).
\end{aligned} \tag{13}$$

Note that second derivative with respect to a_i is negative. Setting this first order condition equal to zero and solving, we obtain the optimal choice for a_i,

$$a_i^* = \frac{\beta(1+\alpha\sigma^2 b_j) + 1}{(1+\alpha\sigma^2)(1+\beta)}. \tag{14}$$

Similarly,

$$\frac{\partial V_i}{\partial b_i} = \beta^2 a_j - \alpha\sigma^2(1+\beta)(b_i(1+\beta) - \beta a_j). \tag{15}$$

Implying that

$$b_i^* = \frac{(\beta^2 + \alpha\sigma^2\beta(1+\beta))}{(1+\beta)^2\alpha\sigma^2}a_j. \tag{16}$$

Firm j solves the mirror image of this problem, and hence,

$$b_j^* = \frac{(\beta^2 + \alpha\sigma^2\beta(1+\beta))}{(1+\beta)^2\alpha\sigma^2} a_i. \tag{17}$$

We can write the reaction functions of the two firms in the form

$$\begin{aligned} a_i^* &= \frac{1}{1+\alpha\sigma^2} + Ab_j, \\ b_j^* &= Ba_i, \end{aligned} \tag{18}$$

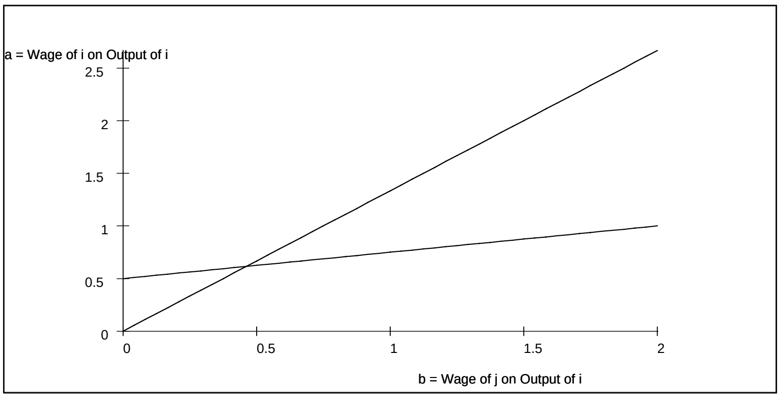
where

$$\begin{aligned} A &= \frac{\beta\alpha\sigma^2}{(1+\alpha\sigma^2)(1+\beta)}, \\ B &= \frac{(\beta^2 + \alpha\sigma^2\beta(1+\beta))}{(1+\beta)^2\alpha\sigma^2}. \end{aligned} \tag{19}$$

In a Nash equilibrium between the two firms, a_i^* and b_j^* must be best responses against each other, as indicated by the intersection of the two linear reactions curves in Figure 1 below.[6]

[6]The figure is drawn for the case $\alpha = \sigma = \beta = 1$. The equilibrium values of the incentives are $a = .61$, $b = .47$, with an implied effort $e = .77$.

Figure 1: Determination of Nash Equilibrium



We now see the strategic interaction between the firms. Firm i raises a_i as b_j rises, because an increase in b_j makes it more costly for manager i to exert effort. The added cost is the increased wage of manager j, which manager i resents. To offset this effect, firm i is forced to raise its reward for the effort of manager i. Similarly, firm j chooses a higher b_j when firm i selects a higher a_i, because it then induces the manager of firm i to moderate his effort, which is beneficial to manager j.

It is easy to show for a given risk factor, $\alpha\sigma^2$, an increase in the degree of competitiveness β shifts the reaction curve for a_i as a function of b_j upwards, while the reaction curve for b_i as a function of a_j shifts downwards. This implies that incentives become sharper when managers are more competitive.

Using the symmetry of the problem, we can equate $a_i = a_j = a$ and $b_i = b_j = b$ and obtain

$$a = \frac{1}{1+\alpha\sigma^2}\frac{1}{1-AB}, \tag{20}$$

$$b = \frac{1}{1+\alpha\sigma^2}\frac{B}{1-AB}. \tag{21}$$

We see that

$$AB = \frac{\beta^3(1+\alpha\sigma^2)+\beta^2\alpha\sigma^2}{(1+\alpha\sigma^2)(1+\beta)^3} < 1. \tag{22}$$

It thus follows that there is a unique intersection of the two reaction curves, which is in the positive region for a and b. However, this solution is an equilibrium only if the implied effort level is positive i.e.,

$$\begin{aligned} e &= a(1+\beta) - b\beta \\ &= \frac{1}{1+\alpha\sigma^2}\frac{1+\beta}{1-AB} - \frac{1}{1+\alpha\sigma^2}\frac{\beta B}{1-AB} \\ &= \frac{1}{1+\alpha\sigma^2}\frac{1+\beta-\beta B}{1-AB} > 0, \end{aligned} \tag{23}$$

or

$$B < \frac{1+\beta}{\beta}. \tag{24}$$

Condition (24) is equivalent to

$$\frac{\beta^3}{(1+\beta)(1+2\beta)} < \alpha\sigma^2, \tag{25}$$

which implies the existence of some positive and increasing function $\beta = f(\alpha\sigma^2)$ such that effort is positive if and only if $\beta < f(\alpha\sigma^2)$.

Proposition 1 *If the risk factor $\alpha\sigma^2$ is sufficiently large relative to the competitive concern β such that condition (25) holds then the unique Nash equilibrium is*

$$\begin{aligned} a^* &= \frac{1}{1+\alpha\sigma^2} + Ab^*, \\ b^* &= Ba^*, \end{aligned}$$

where

$$\begin{aligned} A &= \frac{\beta\alpha\sigma^2}{(1+\alpha\sigma^2)(1+\beta)}, \\ B &= \frac{(\beta^2 + \alpha\sigma^2\beta(1+\beta))}{(1+\beta)^2\alpha\sigma^2}. \end{aligned}$$

If condition (25) does not hold then the unique equilibrium is one in which effort levels are zero. That is,

$$e^* = \max((1+\beta)a^* - \beta b^*, 0). \tag{26}$$

Note that the solution for the equilibrium incentives and the implied effort of the managers are independent of the reservation values of the managers. This result reflects the fact that the expected utility of the managers can be transformed into a linear form in wages implying transferable utility between the manager and the firm. To close the model, we use the free entry condition and set the expected profits to zero, yielding in an interior solution

$$s^* = e^*(1 - a^* - b^*). \tag{27}$$

We can then substitute this value of s^* into the expected utility of each manager to get the common reservation value r^*.

There are two special cases that merit further attention;

(i) For $\beta = 0$, we get $a = \dfrac{1}{1 + \alpha\sigma^2}$, $b = 0$, and $e = \dfrac{1}{1 + \alpha\sigma^2}$.

That is, when there are no competitive preferences there is no need to condition manager i's wages on the performance of manager j. This is irrelevant information in such a case that may only contribute to increase the variance of manager i's compensation.

(ii) If either risk or risk aversion are zero so that $\alpha\sigma^2 = 0$, then the only possible equilibria are with $e_i = e_j = 0$. If $e_i > 0$, then for any b_j, $a_i = 1$. Similarly, if $e_j > 0$ then $a_j = 1$. But each of the firms will increase their b until the effort of the opponent manager drops to zero.

We thus see that some degree of uncertainty is required to have an equilibrium with positive effort. Uncertainty makes it costly to condition the wage of the CEO on the performance of others, and limits the competition among firms that would drive effort to zero. This explains the need for condition (25).

The main result of this paper is that with risk and competitive preferences the wages of managers in the same industry are positively linked.

Proposition 2 *For any $\beta > 0$, the wage for agent i is increasing in the wage of agent j.*

The basic reason for a positive interaction in wages is that conditioning the wage of one manager on the other's effort causes the other manager to moderate his effort. The presence of risk makes such linking costly because it also raises the variance in wages by adding another risk element into the variance of wages. The optimal contract is based on a compromise between these two offsetting considerations. Note, however, that even in the absence of any impact on the other manager's effort, firm i would select a positive b_i.

The reason for this result is that a positive incentive for effort for manager j in the form of a positive a_j, implies that the utility of manager i depends on ε_j. This creates status shocks to manager i. To alleviate this variability in status, the wage of manager i can be made to depend positively on the output of manager j. In fact, if firm i cannot affect e_j, it will set $b_i = \frac{\beta}{1+b} a_j$ so as to reduce the second term in (5) to 0 and provide agent i with full insurance against the random shocks ε_j.

Proposition 2 is in contrast to the Relative Performance Hypothesis, which says that i's wages depend *negatively* on the output of his coworker, because high output of the comanager indicates that luck (rather than effort) influences i's output (Prendergast, 1999, and Gibbons and Waldman, 1999).

We may ask whether this equilibrium is efficient, i.e., whether it is possible to improve welfare by coordinating on decreasing or increasing effort (i.e., weaken or strengthen incentives). There are two sources of inefficiency in this model. One source of inefficiency is the principal agent problem, reflecting informational constrains. The other source are the externalities that agents impose on each other, when each seeks to outdo the other, although at the end they all receive the same reward. Accordingly, there are several standards of efficiency that one may consider here. The first standard is the one that would exist if the principal agent problem could be eliminated, say by making the manager the residual owner. The second standard is the case with a principal agent problem, but where the externalities associated with excessive competition are eliminated by coordination across firms. Finally, we may consider the case without status externalities and no principal-agent problem. Of these, the most natural experiment is to consider the constrained efficient outcome, where the planner faces the same informational difficulties as the firms.

In the constrained efficient case, the socially optimal solution is $e^{sb} = \frac{1}{1+\alpha\sigma^2}$. This solution requires each firm to trade off risk and effort, but eliminates the externality arising from status seeking. If the two firms in an industry can coordinate, they will both offer a wage contract that mitigates the desire of their managers to compete for status, when none can be created. Specifically, they could offer the contract $a = \frac{1}{1+\alpha\sigma^2}\frac{1}{1+\beta}$ and $b = 0$ so that both managers would behave *as if* they do not care about status. If there is no agency problem and no externalities, the first best is to set the effort of all agents to $e^{fb} = 1$, because then the marginal social value of effort equals its marginal cost. However, if the manager is the residual owner so that there is no principal agent problem, but status concerns are present, the uncoordinated outcome would be $e^{nc} = 1 + \beta$. In this case, each manager selects his effort taking the effort of the others as given and the marginal reward for his effort is $1 + \beta$. Note that variance in the wage in this case is independent of effort.

In the uncoordinated rat race, which arises when managers are the residual owners, effort rises in the degree of competitiveness as measured by β. In contrast, effort is independent of status concerns when coordination is possible, either in the second or first best outcome. The equilibrium pattern is that effort tends to initially rise with the competitive concerns β and then decline towards zero. This reflect the way in which the firms (principals) intervene in the process. At low value of β firms offer weak incentives for effort, but as managers become more competitive incentives become sharper and firms raise both a and b. The stronger incentives have countervailing effects on effort, and eventually, the attempt to discourage the effort of the managers of the competing firm dominates.

4 Conclusion

We have shown that managerial competitive preferences may lead to managerial wages being positively correlated within an industry. Our main point is that the competitive effect runs counter to the RPE effect, and hence we have provided an explanation of the lack of RPE in compensation data. Whether the effect on incentives due to preferences being competitive is sufficiently strong to neutralize the RPE effect in reality is an empirical question. However, it is plausible that social interaction rises with proximity, so that workers in the same firm or industry are more likely to care about their relative wages. Viewed from this perspective, the surprising finding of Gibbons and Murphy (1992), that RPE works better for managers that are *far* apart provides some further support to the relevance of social concerns.

We may also relate our model to the extensive use of stocks and options in manager compensation (options alone comprise 35-40% of CEO compensation in the US, according to Murphy 1999). The use of these compensation instruments is rather puzzling, since stock price is a coarse instrument for measuring managerial success; one issue is of course whether managers can affect firm performance much by doing a better job, another issue is that such options tend to reward pure luck (i.e., positive demand or factor shock like decreased oil price) and hence increases the variability of wages unnecessary. The key here is that although stock prices for individual firms are highly variable, they are normally strongly correlated within an industry. Hence, if firm j uses options in the CEO compensation package then it can be optimal for firm i to use options as well, since it insulates manager i from status shocks. This argument can explain why firms use options in the compensation package even if the use of options greatly increases variability of the wage for manager i (and being relatively weakly related to managerial 'effort').

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