

The Dual Role of Peer Groups in Executive Pay: Relative Performance Evaluation versus Benchmarking*

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Abstract:

We study the role of peer groups in determining the structure and the total amount of executive compensation. Our analysis is based on a standard agency model in which the agent's reservation utility is related to the peer group used for performance evaluation. Our main result is that the informativeness criterion proposed by Holmström (1979) is neither a necessary nor a sufficient condition for the optimality of a relative performance evaluation. Whenever the relative performance evaluation is positively related to the agent's reservation utility, the principal faces a trade-off between the benefits from improved risk sharing and the total cost of compensation. If the peer group effect is strong, it can be optimal to evaluate the agent on her own firm performance only. If the relative performance evaluation is negatively related to the agent's reservation utility, it can also prove useful to reward the agent on the basis of uninformative signals. We also study the optimal weighting and composition of the performance index and find that the principal puts lower (higher) weight on an index and on peer firms that are positively (negatively) related with agent's reservation utility. In case of a negative relation it can even be optimal to include firms with uncorrelated cash flows into the index in order to reduce the total compensation.

1 Motivation

Agency theory recommends to evaluate the performance of a firm's management relative to the performance of other firms in the same industry as a means for filtering out common shocks from compensation packages. Evaluating the performance relative to a peer group enables firms to reduce the risk exposure of risk averse managers and thereby to implement a given incentive scheme at a lower cost.¹

The usefulness of relative performance evaluation refers to the optimal structure of compensation contracts but not to the overall level of compensation. Despite the recent public debate on the level of executive compensation, the question of the appropriate amount of pay is usually not addressed in agency models. Regardless of their structure, optimal contracts are designed so that the expected amount of pay equals the agent's exogenously given reservation wage. Thus, from an agency theory perspective, it seems important how managers are paid and not how much compensation they receive in total.

On the other hand, it is a well documented empirical fact that firms frequently use peer groups of similar companies for determining the appropriate level of compensation for their managers, particularly for their chief executive officer (CEO).² This practice is also referred to as (competitive) benchmarking and it is discussed controversially. Critics argue that the benchmarking procedure has led to pay increases that are largely unrelated to firm performance.³ Others seem to regard the benchmarking procedure as a necessary provision for attracting and retaining qualified managers in a competitive managerial labor market.⁴

1 Essentially this insight goes back to Holmstrom (1979 and 1982). See Prendergast (1999) for a survey of related literature.

2 See Bizjak, Lemmon and Naveen (2007) or Jensen, Murphy and Wruck (2004).

3 The Conference Board Commission on Public Trust and Private Enterprise, an association of former CEOs and other experts recommend that compensation committees should "...avoid benchmarking that keeps continually raising the compensation levels for executives", Conference Board Inc. (2003). See also Bizjak, Lemmon and Naveen (2007) and Porac, Wade and Pollock, (1999) for a detailed discussion of the benchmarking process.

4 See e.g. Holmstrom and Kaplan (2003). Interestingly, even leading agency theorists seem to believe that a significant part of the recent increase in executive pay during the past two decades can be attributed to the widespread benchmarking practice, see e.g. Holmström (2005).

We do not attempt to dissolve the benchmarking controversy but we take the dual role of peer groups in determining the structure and the total amount of executive compensation as a starting point for an integrated analysis of peer group related pay. We propose a standard agency model in which the agent's reservation utility is endogenously determined by the structure of her compensation scheme. The key assumption of our analysis is that the relevant peer group for evaluating the agent's performance is related to the group of firms the agent uses for determining her reservation utility. That is, for determining the lowest acceptable amount of total pay, the agent compares the expected value of the compensation package offered by the principal with the compensation offered by those firms against which the principal evaluates her performance.

This idea is consistent with empirical evidence on the benchmarking practice, suggesting that performance comparisons with peer groups play an important role in justifying the total amount of compensation.⁵ From a more theoretical perspective, our model reflects a market for managers where the market participants determine their market value by comparing the adequacy of pay in their current position with the potential rewards in the next best employment alternative.⁶ Finally, our approach is also consistent with the social comparison theory of Festinger (1954) and more recent developments in economic theory suggesting that individuals usually define their utility relative to the utility of a reference group.⁷

The main finding of our analysis is that the informativeness criterion introduced by Holmström (1979) is neither a necessary nor a sufficient condition for the optimality of a relative performance evaluation in the agent's compensation contract when the performance benchmark is related to the agent's reservation utility. For establishing this result, we first show that there exists a trade-off between the potential benefits from improved risk sharing and the total cost of compensation whenever the use of a particular reference group is positively

5 See Porac, Wade and Pollock, (1999). This view seems also consistent with the SEC rules on executive compensation and related person disclosure requiring to disclose "Whether the registrant engaged in any benchmarking of total compensation, or any material element of compensation, identifying the benchmark and, if applicable, its components (including component companies)", SEC (2006).

6 This view is also consistent with Holmström (2005), who states that "Benchmarking is the mechanism of choice for a good reason. The executive market is not competitive in the normal sense, but there is an important element of competition stemming from the ability of executives to see what other executives make in similar situations. Paying CEOs less than they think they are worth based on comparative data is demoralizing."

7 See e.g. Bolton and Ockenfels (2000), Charness and Rabin (2002), Fehr and Schmidt (1999), and Sobel (2005) for a recent survey of this literature.

related to the agent's reservation utility. If the peer group effect on the agent's total compensation is strong enough, it can be optimal to forgo the benefits from improved risk sharing and to do without a relative performance evaluation. A less obvious contracting option arises if the relative performance evaluation is negatively related to the agent's reservation utility. Here, it can even prove useful to deteriorate risk sharing and reward the agent on the basis of uninformative signals in order to reduce the agent's total compensation.

In a linear extension of our basic model, we also analyze the consequences of peer group related reservation utilities on the weighting and the composition of the performance index. Consistent with our general results, we find that for a given performance index an endogenous reservation utility weakens (strengthens) the intensity of relative performance evaluation of management whenever the peer group effect leads to an increase (decrease) of the agent's total compensation. Regarding the optimal index composition we find that the principal puts lower (higher) weight on peer firms that are positively (negatively) related with agent's reservation utility. In case of a negative relation it can even be optimal to include firms with uncorrelated cash flows into the index for reducing the agent's total compensation. Intuitively, firms should prefer to compare the performance of their managers to firms with lower pay levels because this comparison renders the own management as well paid and thereby makes it easier to justify a pay decrease or at least more difficult to justify a pay raise.

Our results are consistent with the empirical literature on executive compensation which has largely failed to provide systematic evidence for the use of relative performance evaluation in practice.⁸ Earlier literature has tried to explain this inconsistency between standard agency theory and company practice with competitive considerations, managers' trading opportunities in the stock market, or the use of inconsistent empirical methods.⁹ According to our analysis this finding can also be a rational contracting choice of properly governed firms for avoiding unnecessary compensation increases.

We also provide a new theoretical rationale for the observed practice of reward for luck. This phenomenon has been attributed to governance failures and tax distortions.¹⁰ In our

8 See Murphy (1999), Abowd and Kaplan (1999), or Dikolli, Hofmann and Pfeiffer (2007) for recent literature reviews. At least some support was found by Antle and Smith (1986), Gibbons and Murphy (1990) and recently Albuquerque (2004).

9 See Aggarwal and Samwick (1999), Maug (2000), Garvey and Milbourn (2003), Albuquerque (2004) and Dikolli, Hofmann and Pfeiffer (2007) for details.

10 See Bertrand and Mullainathan (2001) and Göx (2008).

model, this practice can be used to lower the relevant benchmark for determining the value of the manager's compensation package and thereby help to decrease the overall compensation cost. This result is consistent with the predictions of Oyer (2004), who studies a related model in which the agent's outside opportunities are correlated with own firm performance and the adjustment of compensation contracts is costly.¹¹

The rest of our paper is organized as follows. In section two we explain our model and its main assumptions. In section three we derive the structure of the optimal contract for the general version of our model. In section four we introduce a linear version of our general model from section two and discuss the optimal weighting and composition of the performance index. Section five ends the paper with a summary and discussion of the main results.

2 Model Assumptions

We consider a standard agency model with a risk-neutral firm owner (*the principal*) and a risk- and effort-averse manager (*the agent*). The agent runs the business on the owner's behalf and exerts effort a for doing so. The agent's effort is unobservable for the principal and causes a personal cost of $C(a)$, where a is a continuous variable from a compact interval $A = [0, \bar{a}]$. The cost function is twice differentiable and strictly convex. For assuring an interior solution of the agent's effort selection problem, we assume that $C(0) = 0$ and $C(\bar{a}) = +\infty$.

The firm's operating cash flow x is a stochastic function of the agent's effort, where x can take any value from the closed interval $X = [\underline{x}, \bar{x}]$. The production technology is represented by a conditional distribution $F(x|a)$ with strictly positive density $f(x|a)$ and full support on X . We assume that $F(x|a)$ is twice differentiable with respect to a and that $\partial F(x, a)/\partial a < 0$. The last assumption implies that the agent's effort shifts the distribution of x to the right in the sense of first-order stochastic dominance. Hence, for any two arbitrary effort levels a' and a'' satisfying $a' < a''$, the expected cash flow given effort a'' is strictly higher than the expected cash flow given effort a' .

For motivating the agent to work hard, the principal offers her a performance-based remuneration contract $s(z)$, where z represents the set of performance measures used in the

¹¹ Oyer's model is not a usual agency model. He does neither model a conflict of interest, nor does his model consider the incentive effects of performance based pay or the relative performance evaluation of management, see Oyer (2004) for details.

contract. There are two measures for evaluating the agent's performance. The first performance measure is the firm's own cash flow x , and the second is a signal y representing the performance of a relevant group of peer firms within the same industry segment.¹² Since a remuneration contract based on y only is usually not optimal, we restrict the possible performance measures to $z = x$ and $z = \{x, y\}$. Hence, the agent's compensation contract can take the forms $s(x)$ and $s(x, y)$. Using both performance measures in the contract and evaluating the agent's performance relative to the results of the peer group allows the principal to eliminate the influence of random factors affecting the whole industry and thereby to make the agent's compensation less risky. We denote the agent's utility derived from compensation with $U(s(\cdot))$ and assume that this part of the agents' utility is monotonically increasing, strictly concave and additively separable from the cost of effort.

The above assumptions are standard in contract theory.¹³ The novel element in our analysis is the relation between the practice of relative performance evaluation and the total amount of the agent's compensation. In the standard agency model, this amount is determined by the agent's reservation utility. The reservation utility represents the utility, the agent would derive from alternative employment opportunities outside the current agency relationship. Put differently, the agent's reservation utility is a measure for her opportunity cost of accepting the principal's contract offer.

The focus of almost all agency models is the optimal contract structure and not the total amount of compensation. Therefore, the reservation utility is typically assumed to be an exogenous constant in most agency models; frequently it is also normalized to zero.¹⁴ In our analysis, we depart from this standard assumption and assume that the agent's reservation utility is endogenously determined by the structure of her compensation scheme. To formalize our idea, we assume that the reservation utility takes the following form:

$$H(I) = \underline{H} + I \cdot \Delta, \quad I = \begin{cases} 0 & \text{if } s(z) = s(x) \\ 1 & \text{if } s(z) = s(x, y) \end{cases} \quad (1)$$

The agent's reservation utility comprises a constant \underline{H} and a second term depending on the structure of her compensation scheme. For simplicity, this second term is modeled

12 In this section, we take the composition of the peer group as given, in section 4 we also discuss criteria for the optimal composition of the peer group.

13 See e.g. Christensen and Feltham (2005), chapter 17, Laffont and Martimort (2002), chapter 4, or Mascoll, Whinston and Green (1995), chapter 14.

14 A notable exception is Dutta (2007). He considers a combined moral hazard/adverse selection model assuming that the agent's reservation utility depends on her type.

as the product of a binary indicator variable $I \in \{0, 1\}$ and a constant Δ . The indicator variable determines if the agent's performance is evaluated on the firm's own performance only ($I = 0$), or on the basis of the firm's performance relative to its peer group ($I = 1$). From (1), $H(0) = \underline{H}$ as in a standard model, but $H(1) = \underline{H} + \Delta$. Hence, the introduction of a relative performance evaluation changes the agent's reservation utility by a constant amount of Δ . We do not restrict the sign of Δ , so that the agent's reservation utility can increase or decrease with the introduction of a relative performance evaluation.

The structure of (1) is aimed to capture the idea that the agent's reservation utility generally depends on the total compensation in her peer group. That is, for determining the lowest acceptable amount of total pay, the agent compares her compensation with the compensation of other executives in comparable firms. We argue that the relevant peer group for evaluating the agent's performance is often closely related to the group of firms the agent uses for determining her reservation utility. For example, if the performance of an investment bank is evaluated against the performance of a particular group of other investment banks, it seems natural that managers within the group also determine their acceptable pay levels by comparing the value of their compensation packages with those of other managers within the group. By contrast, firms outside the performance peer group are less relevant for the determination of the reservation utility because they are not considered as relevant peers.

As explained in the introduction, this idea is not only consistent with empirical evidence on the benchmarking practice and recent development in economic theory stressing the importance of social preferences, but also with the view of a market for managers in which market participants determine their market value by comparing the adequacy of pay in their current position with the potential rewards in the next best employment alternative.

Based on these assumptions, we next analyze the structure of the optimal compensation contract.

3 Optimal contracting with endogenous reservation utility

The risk-neutral principal aims to maximize the difference between the expected cash flow and the expected remuneration of the agent, $V(x, s(z)|a) = E[(x - s(z))|a]$. The optimal contract maximizes the principal's objective function subject to the following two constraints:

$$a = \underset{a'}{\operatorname{argmax}} E[U(s(z)|a')] - C(a'), \quad (2)$$

$$E[U(s(z)|a)] - C(a) \geq H(I), \quad (3)$$

where $E[U(s(z)|a)] = \int U(s(z)) \cdot f(z|a) \cdot dz$ is the agent's expected utility derived from compensation contract $s(z)$. The first constraint in (2) is the agent's incentive constraint. It ensures that the principal correctly anticipates the agent's utility maximizing effort choice when designing the contract. The second constraint in (3) is the agent's participation constraint. It assures that the agent weakly prefers to accept the contract instead of refusing it. A rational agent will do so, if her expected net utility from the contract is not lower than her reservation utility. The solution to this problem is found by a pointwise optimization of the Lagrangian function corresponding to the principal's problem. It can be shown that the optimal contract requires that both constraints are binding. The optimal contract can be characterized by the following condition:

$$\frac{1}{U'(s(z))} = \lambda + \mu \cdot \frac{f_a(z|a)}{f(z|a)}, \quad (4)$$

where $U'(s(z))$ is the agent's marginal utility derived from monetary compensation, λ is the multiplier of the participation constraint, μ is the multiplier of the incentive constraint, and $f_a(z|a)$ is the partial derivative of the density function with respect to a . The expression in (4) can be interpreted as follows. Whenever the likelihood ratio $f_a(z|a)/f(z|a)$ is not a constant, the agent's compensation depends in a non-trivial fashion on the realizations of the noisy set of performance measures represented by z . By contrast, optimal risk sharing would require that the risk neutral principal fully insures the agent by paying her a fixed salary, but with a fixed salary the agent would have no incentives to exert effort. The optimal contract establishes the best compromise between motivating the agent to work hard and the cost of a departure from optimal risk sharing.

According to what has been established by *Holmström* (1979) as the informativeness principle, the principal can always attain an improved solution of the fundamental trade-off between risk and incentives by offering the agent a contract $s(x, y)$ rather than $s(x)$ whenever it does not hold that

$$\frac{f_a(x, y|a)}{f(x, y|a)} = h(x, a), \quad (5)$$

where $h(x, a)$ is an arbitrary function of x and a . If condition (5) holds, the signal y is not informative about a given x is observed. All information that can be inferred about the agent's action via y is already included in x . Adding y to a contract based on x simply adds noise to the contract without providing additional effort incentives.

If (5) is not true, the signal y is informative about a given x is observed. The principal can use an informative signal to remove a part of the agent's compensation risk by linking her pay to x and y instead of evaluating the agent's performance on the basis of x only. It follows that the principal can reduce his expected cost for inducing a given effort level a' by offering the agent a contract $s(x, y)$ instead of a contract $s(x)$ so that the agent's utility from monetary compensation is held constant. That is, a contract satisfying

$$E[U(s(x, y)|a')] = E[U(s(x)|a')] \quad \text{and} \quad E[s(x, y)|a'] < E[s(x)|a'] \quad (6)$$

can be implemented whenever the signal y is informative in the sense of *Holmström (1979)*.¹⁵ In a standard model with an exogenous and constant reservation utility \underline{H} condition (6) is equivalent to the statement that the risk premium associated with the new contract,

$$R(s(x, y)|a') = E[s(x, y)|a'] - CE(0, a'), \quad (7)$$

is strictly lower than the risk premium associated with the old contract,

$$R(s(x)|a') = E[s(x)|a'] - CE(0, a'), \quad (8)$$

where $CE(0, a') = U^{-1}(\underline{H} + C(a'))$ is the agent's certainty equivalent of the risky compensation scheme given that the participation constraint is binding. Because the reservation utility is constant, both remuneration contracts yield an expected utility of $\underline{H} + C(a')$, and thus, identical certainty equivalents. It follows from (7) and (8) that

$$E[s(x)|a'] - E[s(x, y)|a'] = R(s(x)|a') - R(s(x, y)|a') > 0. \quad (9)$$

From (9), the expected amount of compensation, the principal can save by moving from a contract $s(x)$ to a contract $s(x, y)$ without reducing the agent's expected utility, is equivalent to the difference in the agent's risk premiums associated with the two contracts. In the standard model, the principal can collect the rent from improved risk sharing because the principal designs the contract so that the agent's expected net utility for all possible contracts equals his exogenous reservation utility.

With an endogenous reservation utility, the introduction of a relative performance evaluation has two effects. As in the standard agency model, the inclusion of an informative signal y into the optimal contract can be used to reduce the agent's risk premium but it also changes the agent's reservation utility by the factor $H(1) - H(0) = \Delta$. If $\Delta < 0$, the

¹⁵ See *Holmström (1979)*, Proposition 3.

two effects are working in the same direction. That is, the principal cannot only use the informative signal y to make the agent's compensation less risky but also induce the agent to accept a contract with a lower expected utility. It should be clear that this constellation reinforces the standard risk sharing argument in favor of a relative performance evaluation.

If $\Delta > 0$, however, the risk sharing effect works in the opposite direction of the reservation utility effect. In this case, the principal can still use an informative signal to reduce the risk in the agent's compensation contract but at the same time the use of y in the contract increases the agent's reservation wage. The optimal solution of this trade-off yields the following result:

Proposition 1: *Let y be an informative signal in the sense of Holmström (1979). With an endogenous reservation utility as defined in (1) and $\Delta > 0$, a relative performance evaluation contract based on x and y pareto dominates a contract based on x only, if the reduction of the agent's risk premium is larger than the increase of the agent's certainty equivalent for satisfying her participation constraint. Otherwise y should not be used in the optimal contract. **Proof:** Suppose the principal offers the agent a contract $\bar{s}(x, y)$ so that the agent takes the action a' and the participation constraint in (3) is binding. From the definition of the agent's risk premium and (3), the expected cost of the new contract equals $E[\bar{s}(x, y)|a'] = R(\bar{s}(x, y)|a') + CE(1, a')$, so that $E[\bar{s}(x, y)|a'] < E[s(x)|a']$ if and only if*

$$R(s(x)|a') - R(\bar{s}(x, y)|a') > CE(1, a') - CE(0, a') \quad (10)$$

where $CE(1, a') = U^{-1}(\underline{H} + \Delta + C(a')) > CE(0, a')$ and $E[s(x)|a']$ is defined in (8).

The result in Proposition 1 shows that the informativeness of a signal is generally not a sufficient condition for justifying its use in an optimal compensation contract whenever the comparison of the agent's performance with a peer group also affects the agent's acceptable amount of pay. The fact that the peer group performance is informative about the effort of a firm's management is only a sufficient argument for a relative performance evaluation if this comparison does not increase the management's reservation utility ($\Delta < 0$). Whenever the relative performance increases the management's reservation utility ($\Delta > 0$), the usefulness of an informative signal for contracting depends on the trade-off between the benefits from an improved risk sharing and the cost of an increasing reservation utility.

Intuitively, the first scenario is more likely if the average remuneration within the peer group is lower than the remuneration of the firm's own management, whereas the second scenario is more likely for firms with remuneration well below the average level of their peer

group. Here, the comparison with well paid peers may result in a demand for an increased remuneration for the firm's management. These theoretical predictions are consistent with the empirical findings of *Bizjak, Lemmon and Naveen (2007)*, who analyze the impact of peer groups on the level of executive compensation. Their main finding is that those executives who are paid below the median of their industry peers receive more frequently and higher pay raises than executives who are already paid above the median of their peer group.

The following Corollary to Proposition 1 shows that our analysis does not only provide new insights into the usefulness of informative signals but also into the usefulness of uninformative signals.

Corollary 1: *Let y be an uninformative signal in the sense of Holmström (1979). With an endogenous reservation utility as defined in (1) and $\Delta < 0$, a relative performance evaluation contract $\bar{s}(x, y)$ pareto dominates a contract $s(x)$, if condition (10) holds. **Proof:** If y is not informative and $\Delta < 0$, $R(\bar{s}(x, y)|a') > R(s(x)|a')$ and $CE(0, a') > CE(1, a')$. Rearranging (10) yields that $E[\bar{s}(x, y)|a'] < E[s(x)|a']$ if and only if $CE(0, a') - CE(1, a') > R(\bar{s}(x, y)|a') - R(s(x)|a')$.*

The result in Corollary 1 implies that the informativeness principle is not even necessary for establishing the usefulness of a relative performance evaluation. If the peer group effect causes a decrease of the agent's reservation utility, the principal is better off by including the uninformative signal into the agent's remuneration contract even if the new contract increases the agent's risk premium. As long as the increase of the agent's risk premium is smaller than the increase of the agent's certainty equivalent required for satisfying her participation constraint, the benefits of a relative performance evaluation are higher than the additional cost.

So far, our analysis has shown that the informativeness principle is neither a sufficient nor a necessary condition for the preferability of relative performance evaluation when the benchmarking procedure affects the agent's reservation utility. In many situations, however, the optimal reaction to an endogenous reservation utility need not be restricted to a decision on the use of a relative performance evaluation per se, but it can also consist of adjusting the optimal pay scheme. In the next section, we analyze this alternative in the context of a linear agency model.

4 Optimal benchmarking in a LEN setting

To provide more detailed insights into the consequences of an endogenous reservation utility on the optimal design of compensation contracts, we analyze a linear version of our general agency model in section 2 in which we allow the firm to construct its own performance benchmark. This setting allows us to study the relation between the agent's reservation utility, the optimal intensity of the relative performance evaluation and the optimal composition of the performance benchmark.

In what follows, we assume that the operating cash flow of the firm, $x = a + \varepsilon$, is a linear function of the agent's effort and a normally distributed noise term $\tilde{\varepsilon}$ with zero mean and variance σ^2 . For motivating the agent, the principal offers her a linear remuneration contract

$$s(z) = w + v \cdot z, \quad z = x - \alpha \cdot y. \quad (11)$$

Here, w is a fixed salary, and $v \cdot z$ is the performance-based part of the agent's compensation. The parameter v is the bonus coefficient placed on the performance measure z , where z is defined as the difference between the firm's operating cash flow and the weighted performance of the peer group. The parameter $\alpha \geq 0$ represents the weight placed on the performance benchmark and measures the intensity of the relative performance evaluation in the agent's remuneration contract. In contrast to section 2, the benchmark y is no longer given but can be designed according to the firm's contracting requirements. The index is constructed as a weighted sum of the cash flows of a group of n peer firms

$$y = \sum_{j=1}^n \beta_j \cdot x_j, \quad (12)$$

where the parameter $\beta_j \geq 0$ denotes the weight placed on the cash flow of firm j . As for our representative firm, the operating cash flow of firm j , $x_j = a_j + \varepsilon_j$, is a linear function of the management's effort a_j and a normally distributed noise term ε_j with zero mean and variance σ_j^2 . We assume that all firms are working in the same industry segment, so that the noise terms are positively correlated with covariance $\sigma_{jk} > 0$. To distinguish the covariance of the cash flows within the index from the correlation between the cash flows of the representative firm and its peers, we denote the covariance between ε and ε_j with σ_{xj} . From these definitions, the total variance of the benchmark index and the covariance between the index and the cash flow of our representative firm are given as follows:

$$\sigma_y^2(\boldsymbol{\beta}) = \sum_{j=1}^n \beta_j^2 \cdot \sigma_j^2 + 2 \sum_{j=1}^n \sum_{k=1}^n \beta_j \beta_k \sigma_{jk}, \quad \sigma_{xy}(\boldsymbol{\beta}) = \sum_{j=1}^n \beta_j \sigma_{xj}, \quad (13)$$

where $\boldsymbol{\beta} = (\beta_1, \dots, \beta_j, \dots, \beta_n)$ is the vector of all index weights used in y . The linear version of our model permits us to provide a more elaborate analysis of the link between the pay scheme and the agent's reservation utility. As in (1), we assume that the agent's reservation utility comprises two components, a minimum utility level \underline{H} and a second part depending on the structure of the compensation contract:

$$H(\alpha, \boldsymbol{\beta}) = \underline{H} + \lambda(\alpha) \cdot \sum_{j=1}^n h(\beta_j) \cdot \Delta_j. \quad (14)$$

In contrast to the general model in (1), the expression in (14) accounts for the possibility that the agent's reservation utility can vary with the weight of the relative performance evaluation in her pay scheme and the relative importance of individual firms within the index.¹⁶ The first effect is captured by the function $\lambda(\alpha)$, and the second by the firm specific component $h(\beta_j) \cdot \Delta_j$. We assume that both, $\lambda(\alpha)$ and $h(\beta_j)$ are arbitrary but monotonically increasing functions of the incentive weights α and β_j , respectively. This assumption should be intuitively appealing. It implies that the general importance of the relative performance evaluation for the agent's reservation wage increases with the incentive weight placed on the index, and that the importance of firm j is increasing with its weight in the index. Finally, Δ_j is a firm specific constant with arbitrary sign as Δ in (1). It can be interpreted as a measure for the difference of pay levels among individual firms. If $\Delta_j > 0$, the pay level in firm j is larger than in the representative firm, and if $\Delta_j < 0$ the opposite holds.

To derive closed form solutions for the optimal compensation contract, we assume that the agent exhibits a negative exponential utility function with constant absolute risk aversion, $U(s(z), C(a)) = -\exp^{-r[s(z)-C(a)]}$, where r is the agent's coefficient of absolute risk aversion. Combined with the assumption of normally distributed noise terms, this particular utility function allows us to represent the agent's objective function by her certainty equivalent:

$$CE = E[s(z)] - C(a) - R(s(z)), \quad R(s(z)) = \frac{r}{2} \cdot \text{Var}[s(z)]. \quad (15)$$

The agent's certainty equivalent comprises her expected compensation $E[s(z)]$, her cost of effort $C(a)$, and the risk premium $R(s(z))$. The risk premium is an increasing function of r and the variance of the agent's compensation, $\text{Var}[s(z)]$. For determining the optimal contract, we first evaluate the expectation and the variance of the agent's remuneration. Using the definitions of the contract in (11) and for the variance and covariance of the index

¹⁶ It should be evident that (1) is actually a special case of (14) with $\lambda(\alpha) = I$ and $\sum_{j=1}^n h(\beta_j) \cdot \Delta_j = \Delta$.

in (13) we get the following expressions:

$$E[s(z)] = w + v \cdot (a - \alpha \cdot \sum_{j=1}^n \beta_j \cdot a_j) \quad (16)$$

$$Var[s(z)] = v^2 \cdot (\sigma_x^2 + \alpha^2 \sigma_y^2(\boldsymbol{\beta}) - 2\alpha \cdot \sigma_{xy}(\boldsymbol{\beta})) = v^2 \cdot \sigma_z^2(\alpha, \boldsymbol{\beta}) \quad (17)$$

The derivation of the optimal contract starts with the agent's effort choice for a given compensation scheme. Substituting the expressions in (16) and (17) into the agent's objective function in (15) and maximizing it with respect to a yields the following solution:

$$v = C'(a) \quad (18)$$

Condition (18) states that the agent's optimal effort is determined by equating her expected marginal compensation with her marginal cost of effort, $C'(a)$. The optimal effort is decreasing in the agent's marginal cost and increasing in the weight placed on the performance measure z . Anticipating the agent's optimal response on stage two of the contracting game, the principal designs the contract so that the agent's participation constraint is binding. Solving $CE = H(\alpha, \boldsymbol{\beta})$ for the agent's expected pay and substituting for $E[s(z)]$ into the principal's objective function yields the principal's net surplus from the agency relation:

$$V(a, v, \alpha, \boldsymbol{\beta}) = E[x] - C(a) - R(s(z)) - H(\alpha, \boldsymbol{\beta}). \quad (19)$$

This surplus comprises the expected cash flow minus the agent's cost of effort, her risk premium and the monetary equivalent of her reservation utility. Using the incentive constraint in (18) and the fact that $E[x] = a$, and maximizing the resulting expression with respect to a yields the desired effort level from the principal's perspective and the optimal incentive weight placed on the performance measure z :

$$v^* = C'(a) = \frac{1}{1 + r \cdot C''(a) \cdot \sigma_z^2(\alpha, \boldsymbol{\beta})} \quad (20)$$

The expression in (20) is the standard result for the optimal incentive weight in a linear agency model. It says that the performance weight in the optimal compensation contract should decrease in the agent's coefficient of absolute risk aversion (r), the slope of her marginal effort cost ($C''(a)$), and in the variance of the underlying performance measure ($\sigma_z^2(\alpha, \boldsymbol{\beta})$).¹⁷

It can be seen from (20) that the parameter α and the vector of firm weights $\boldsymbol{\beta}$ are relevant for determining the aggregate variance of the performance measure z . For a bonus

¹⁷ See e.g. Hemmer (2004), or Christensen and Feltham (2005).

coefficient v and a given vector of firm specific index weights in y , the optimal weight on z in the remuneration contract is found by maximizing (19) with respect to α :

$$\frac{\partial V}{\partial \alpha} = -\frac{1}{2} \cdot r \cdot v^2 \cdot \frac{\partial \sigma_z^2(\alpha, \boldsymbol{\beta})}{\partial \alpha} - \frac{\partial H(\alpha, \boldsymbol{\beta})}{\partial \alpha} \leq 0 \quad (21)$$

The optimality condition in (21) shows that the principal faces a trade-off between minimizing the variance of the performance measure and minimizing the agent's reservation utility. As a benchmark, we consider first the solution for a standard agency model with a constant reservation utility. For that case $\partial H(\alpha, \boldsymbol{\beta})/\partial \alpha = 0$, so that the optimal index weight minimizes the variance of the performance measure and thereby the agent's risk premium. The variance of z is minimized by setting α equal to the ratio of the covariance between x and y and the variance of y :¹⁸

$$\alpha^* = \frac{\sigma_{xy}(\boldsymbol{\beta})}{\sigma_y^2(\boldsymbol{\beta})}. \quad (22)$$

Since $\sigma_z^2(\alpha, \boldsymbol{\beta}) = \sigma_x^2$ for $\alpha = 0$, the optimal intensity of relative performance evaluation reduces the variance of the performance measure z from σ_x^2 to $\sigma_z^2(\alpha^*, \boldsymbol{\beta}) = \sigma_x^2 - (\sigma_{xy}(\boldsymbol{\beta}))^2/\sigma_y^2(\boldsymbol{\beta})$. This variance reduction minimizes the agent's risk premium and thereby renders it attractive for the principal to induce a higher equilibrium effort than without a relative performance evaluation. This result is consistent with the informativeness principle because y is correlated with x and therefore informative about the agent's action given x is observed.

In our model, the reservation utility is related to the intensity of the relative performance evaluation. Therefore, we obtain the following result.

Proposition 2: *If the agent's reservation utility is increasing (decreasing) in the intensity of relative performance evaluation, the optimal intensity α^{**} is strictly lower (higher) than required for minimizing the variance of the performance measure z . **Proof:** Evaluating the optimality condition in (21) for the variance minimizing index weight α^* in (22) yields:*

$$\left. \frac{\partial V}{\partial \alpha} \right|_{\alpha=\alpha^*} = -\frac{\partial H(\alpha, \boldsymbol{\beta})}{\partial \alpha}$$

*it follows that $\alpha^{**} < \alpha^*$ if $\partial H(\alpha, \boldsymbol{\beta})/\partial \alpha > 0$ and $\alpha^{**} > \alpha^*$ if $\partial H(\alpha, \boldsymbol{\beta})/\partial \alpha < 0$.*

According to Proposition 2, an agent with an endogenous reservation utility can weaken or intensify the relative performance evaluation of management. The firm find it less attractive to compare the agent's performance with the results of peer firms whenever this comparison

¹⁸ The expression in (22) is consistent with the optimal linear aggregation rules for performance signals in Banker and Datar (1989).

leads to an increase of the agent's total compensation. This scenario is most likely if the average remuneration in the peer group is higher than in the representative firm. Moreover, if

$$\left. \frac{\partial V}{\partial \alpha} \right|_{\alpha=0} = r \cdot v^2 \cdot \sigma_{xy}(\boldsymbol{\beta}) - \lambda'(0) \cdot \sum_{j=1}^n h(\beta_j) \cdot \Delta_j < 0, \quad (23)$$

the principal does best with evaluating the agent's performance on the basis of x only. This solution corresponds to the second case in Proposition 1 for which condition (10) does not hold. From (23) this solution obtains in the linear model, if the agent's marginal risk premium evaluated at $\alpha = 0$ is smaller than the marginal increase of the reservation utility so that the potential benefits of a relative performance evaluation are outweighed by its cost. If (23) does not hold, the optimal level of relative performance evaluation becomes

$$\alpha^{**} = \alpha^* - \frac{\lambda'(\alpha) \cdot \sum_j h(\beta_j) \cdot \Delta_j}{r \cdot v^2 \cdot \sigma_y^2(\boldsymbol{\beta})}. \quad (24)$$

The expression in (24) shows that $\alpha^{**} < \alpha^*$ whenever $\partial H(\alpha, \boldsymbol{\beta})/\partial \alpha = \lambda'(\alpha) \cdot \sum_j h(\beta_j) \cdot \Delta_j > 0$; otherwise $\alpha^{**} > \alpha^*$. Since $\lambda'(\alpha) > 0$ by assumption, the sign of the relevant term depends on the sign of the weighted sum of the firm specific constants Δ_j . If we interpret Δ_j as a measure for the difference of pay levels among firms, the weighted sum $\sum_j h(\beta_j) \cdot \Delta_j$ is strictly positive if all firms in the peer group are paying more than in the representative firm and vice versa. If the signs of the Δ_j are mixed, the sign of the aggregate depends on the weights of individual firms in the index.

So far we did not consider the composition of the performance index y . This task is performed by adjusting the weights β_j according to the contracting requirements of the principal. The optimal weight of firm j is found by maximizing the principal's objective function in (19) with respect to β_j :

$$\frac{\partial V}{\partial \beta_j} = -\frac{1}{2} \cdot r \cdot v^2 \cdot \frac{\partial \sigma_z^2(\alpha, \boldsymbol{\beta})}{\partial \beta_j} - \frac{\partial H(\alpha, \boldsymbol{\beta})}{\partial \beta_j} \leq 0. \quad (25)$$

As for the index weight α , the principal faces a trade-off between minimizing the variance of the performance measure and the marginal impact of firm j on the agent's reservation utility. As a benchmark, we consider first the standard solution for an exogenous reservation utility. If $\partial H(\alpha, \boldsymbol{\beta})/\partial \beta_j = 0$, the optimal index weight is determined by minimizing σ_z^2 with respect to β_j . For a given index weight α and given weights of the other firms within the peer group, the optimal weight of company j is given by the following expression:

$$\beta_j^* = \frac{\sigma_{xj}}{\alpha \cdot (\sigma_j^2 + \sum_{k=1}^n \beta_k \sigma_{jk})}. \quad (26)$$

From (26), β_j^* is increasing in the covariance σ_{xj} and decreasing in its contribution to the variance of y . Intuitively, the cash flows of firm j are more informative about the agent's effort, the higher the correlation between x and x_j and the lower the contribution of firm j to the variance of the index y . Using the expression for α in (22), β_j^* becomes:

$$\beta_j^* = \frac{\sigma_{xj}}{\sigma_{xy}(\boldsymbol{\beta})} \bigg/ \frac{\sigma_j^2 + \sum_{k=1}^n \beta_k \sigma_{jk}}{\sigma_y^2(\boldsymbol{\beta})}. \quad (27)$$

According to (27), the variance minimizing index weight of firm j for the standard case of a constant reservation utility can be expressed as the ratio between firm j 's contributions to the covariance between x and y and the variance of y . That is, the significance of firm j for the composition of the index is determined by its relative contributions to the two factors determining the index weight in (22).

With an endogenous reservation utility, we obtain the following result.

Proposition 3: *If the agent's reservation utility is increasing (decreasing) in the index weight of firm j , firm j gets a lower (higher) weight than required for minimizing the variance of the performance measure z . **Proof:** Evaluating the optimality condition in (25) for the variance minimizing index weight β_j^* in (26) yields:*

$$\left. \frac{\partial V}{\partial \beta_j} \right|_{\beta_j = \beta_j^*} = - \frac{\partial H(\alpha, \boldsymbol{\beta})}{\partial \beta_j}$$

*it follows for the optimal index weight β_j^{**} that $\beta_j^{**} < \beta_j^*$ if $\partial H(\alpha, \boldsymbol{\beta})/\partial \beta_j > 0$ and $\beta_j^{**} > \beta_j^*$ if $\partial H(\alpha, \boldsymbol{\beta})/\partial \beta_j < 0$.*

Proposition 3 suggests that the optimal index composition can be significantly affected by the link between the relative performance evaluation and the agent's reservation utility. The optimal index weight of firm j depends on its marginal contribution to the agent's reservation utility. If this contribution is positive, the optimal contract puts less weight on firm j , and if this contribution is negative, firm j gets a higher weight within the index. Intuitively, the firm puts more weight on firms with lower pay levels and less weight on firms with higher pay levels than its own. If

$$\left. \frac{\partial V}{\partial \beta_j} \right|_{\beta_j = 0} = r \cdot v^2 \cdot \alpha^* \cdot \sigma_{xj} - \lambda(\alpha^*) \cdot h'(\beta_j) \cdot \Delta_j < 0, \quad (28)$$

that is, if the marginal increase of the reservation utility is larger than the agent's marginal risk premium given that $\beta_j = 0$, firm j is not included in the index. Since $\lambda(\alpha^*)$ and $h'(\beta_j)$ are positive by assumption, this case requires $\Delta_j > 0$. The higher Δ_j the higher the

increase of the agent's reservation utility and the less likely is it that firm j is included in the benchmark. If (28) is not true, the following closed form solution obtains:

$$\beta_j^{**} = \beta_j^* - \frac{\lambda(\alpha) \cdot h'(\beta_j) \cdot \Delta_j}{\alpha^2 \cdot \left(\sigma_j^2 + \sum_{k=1}^n \beta_k \sigma_{jk} \right) \cdot r \cdot v^2}. \quad (29)$$

The expression in (29) shows that the sign of the difference between the optimal firm weight β_j^{**} and the variance minimizing firm weight β_j^* depends on the sign of Δ_j . If $\Delta_j > 0$, $\beta_j^{**} < \beta_j^*$ but if $\Delta_j < 0$, $\beta_j^{**} > \beta_j^*$. This result is also intuitively appealing because it suggests that the endogeneity of the reservation utility favors a comparison with firms offering lower pay levels to their management. Interestingly, the difference between β_j^* and β_j^{**} does not depend on the covariance between x and x_j . We can therefore make the following addendum to Proposition 3:

Corollary 2: *Whenever the agent's reservation utility is decreasing in the index weight of firm j , firm j gets a positive weight even if x_j is not informative about the agent's effort.*

Proof: *An uninformative signal has $\beta_j^* = 0$ from (26), but for $\Delta_j < 0$ and $\beta_j^* = 0$, $\beta_j^{**} > 0$ from (29).*

The observation in Corollary 2 complements the observation in Corollary 1. The suggested link between the structure of the firm's performance measurement system and the agent's reservation utility can make it reasonable to compare the performance of other firms with uncorrelated cash flows if this comparison helps the firm to lower the total compensation of its own management. Intuitively, this outcome can best be achieved if the firm's management is compared to firms with lower pay levels because this comparison renders the own management as well paid and thereby makes it more difficult to justify a pay raise.

5 Summary and discussion of results

We study the dual role of peer groups in determining the structure and the total amount of executive compensation in the context of a standard agency model in which the agent's reservation utility is endogenously determined by the structure of her compensation scheme. We assume that the relevant peer group for evaluating the agent's performance is related to the group of firms the agent uses for determining her reservation utility.

Our main result is that the informativeness criterion is neither a necessary nor a sufficient condition for the optimality of a relative performance evaluation in the agent's compensation contract when the performance benchmark is related to the agent's reservation utility. We

demonstrate that there is generally a trade-off between the benefits from improved risk sharing and the total cost of compensation when the practice of relative performance is positively related to the agent's reservation utility. If the peer group effect on the agent's total compensation is strong, it can be optimal to evaluate the agent on her own firm performance only. Whenever the relative performance evaluation is negatively related to the agent's reservation utility, it can prove useful to reward the agent on the basis of uninformative signals for reducing the agent's total compensation.

In a linear extension of our basic model, we find that for a given performance index an endogenous reservation utility weakens (strengthens) the intensity of relative performance evaluation of management whenever the peer group effect leads to an increase (decrease) of the agent's total compensation. Regarding the optimal index composition we find that the principal puts lower (higher) weight on peer firms that are positively (negatively) related with agent's reservation utility. In case of a negative relation it can even be optimal to include firms with uncorrelated cash flows into the index in order to reduce the total compensation. Intuitively, firms should prefer to compare the performance of their managers to firms with lower pay levels because this comparison renders the own management as well paid and thereby makes it easier to justify a pay decrease or at least more difficult to justify a pay raise.

These results are consistent with the empirical literature on executive compensation which has largely failed to find a systematic evidence for the use of relative performance evaluation in practice. According to our analysis this finding can be the result of a rational contracting choice of properly governed firms for avoiding unnecessary compensation increases. We also provide a theoretical rationale for the observed practice of reward for luck. In our model, this practice can be used to lower the relevant benchmark for determining the value of the manager's compensation package and thereby help to decrease the overall compensation cost.

Our study is one of the first attempts to relate the question of optimal contract design to the amount of total pay. We see our model as a first step towards a better understanding of the relation between the structure of compensation contracts and the determinants of current levels of executive pay. Further theoretical research is needed for developing a full understanding of the pay process.

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