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Internal monitoring, regulation, and compensation of top executives in banks

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Abstract

This paper examines the relation between incentive pay, monitoring, and regulatory requirements in banks. Using a one-period model with asymmetrical information between the bank owner and the top management team, as well as within the team itself, we show that (1) incentive pay increases the mutual-monitoring activity among top executives; (2) senior executives, especially the CEO, collect more incentive pay than their subordinates; and (3) bank regulations, such as capital adequacy (CAD) requirements, reduce the absolute amount of incentive pay granted to executives.

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1. Introduction

Monitoring and performance pay are the most popular means for aligning the manager's interests with those of the owners. However, the design of successful monitoring and incentive schemes is a complicated task in firms. This is because firm's performance depends on the joint effort of executive teams, an effort that depends on the personal contribution of

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each team member to the firm's output, which is partly unobservable. Zingales (2000) highlights the importance of human capital and teamwork in the modern firm.

In recent years, firms boosted up performance pay and in particular option grants. This is consistent with the agency theory that suggests performance pay as a substitute to monitoring. Holmstrom (1982) argues that the primary role of a principal is to administer incentive schemes that police his or her agents in a credible way rather than to monitor them. Interestingly, some studies (see De-Meza & Southey, 1999, for example) still conclude that in many firms there is too much monitoring and not enough performance pay.

Several studies (e.g., Ang, Lauterbach, & Schreiber, in press; Crawford, Ezzell, & Miles, 1995; John, Saunders, & Senbet, 2000; Noe, Rebello, & Wall, 1996) discuss the importance of incentive fees in the banking sector. John et al. (2000) argue that capital and asset regulations have only indirect effects on managerial incentives and thus on managerial decisions. They conclude that top management compensation and incentive pay are a more effective tool for influencing managerial behavior.

The main purpose of the study is to discuss the incentive pay of members of the top management team. We show that incentive pay and *internal* monitoring are complementary rather than substitutes. Our model also predicts that more senior executives would receive more incentives in order to encourage them to internally monitor. Finally, we show how regulations, such as capital adequacy (CAD) requirements, affect the amount of incentive pay of the top management in banks in a way that might impede managerial quality.

The rest of the paper is organized as follows. Section 2 presents the model. In Section 3, we introduce the CAD regulation and examine its impact. Section 4 concludes.

2. The model

Adapting the framework of Hirshleifer and Suh (1992), we assume that the bank's production technology comprises two stages: loan origination and loan oversight. Specifically, in the origination stage, the top bank executives decide on the mix of risky loans versus riskless assets and decide on whom to grant risky loans. We assume that screening risky loan requests consumes efforts in data collection, analysis, evaluation, and pricing. Each executive's efforts are costlessly observable inside and outside the bank, and the collective efforts of the top n executives are denoted by $E_{\mathrm{O}}=\{e_1^{\mathrm{O}}+\ldots+e_n^{\mathrm{O}}\}$.

In the loan oversight stage, bank executives must continuously examine the financial condition of the borrower and the actual value of the collateral. In the oversight stage, we assume that executive j's efforts are unobservable to any outsider (including the owner). However, executives in the bank may learn about executive j's effort at some personal cost, i.e., via costly internal monitoring. Thus, bank owners encourage efficient internal monitoring among top executives. The expected efforts of the top n executives is denoted as $E_{\mathrm{X}}=\{e_1^{\mathrm{X}}+\ldots+e_n^{\mathrm{X}}\}$.

The model is a one-period model with risk neutral agents and asymmetrical information among all players. The labor market is assumed to be competitive. At the beginning of the period (Time 0), a bank owner invests K_0 and establishes a bank. Then, she hires a CEO and another $n-1$ executives to run the bank and signs compensation contracts with them. Denote the highest ranking manager by subscript n (the CEO) and all other top executives by subscript j $\{j=1\ldots n-1)$, where $j>$i, reflects the fact that executive j is a higher ranking executive than i in the bank organizational hierarchy.

At Time 0, the bank raises deposits (Dep), provides risky loans to the public, and/or invests the rest in riskless assets. At Time 1, all bank assets are liquidated and the bank equity is transferred to the owner net of cash compensation and bank stocks paid to the executives according to their personal compensation contracts. The expected value of bank assets at Time 1 is:

$$E_V = P(E_O)E_{rsk} + [1 - P(E_O)]V_F = V_F + P(E_O)(E_{rsk} - V_F)$$

where V_F is the future certain cash flow from the riskless assets, $P(E_O)$ is the proportion of the bank's asset portfolio invested in risky loans, and E_{rsk} is the expected payoff of the risky loans.

Risky loans are assumed to yield either a high payoff, V_H, with probability $Q(E_X)$, or a low payoff, V_L, with probability $[1-Q(E_X)]$, where $V_H > V_F > V_L$. Thus, the expected value of the risky loans is:

$$E_{rsk} = Q(E_X)V_H + [1 - Q(E_X)]V_L t = V_L + Q(E_X)(V_H - V_L)$$

We assume that $P(E_O)$ and $Q(E_X)$ are of the same type $(1 > Q(E_X),\ P(E_O) \geq 0)$; both are monotonically increasing with managerial efforts, differentiable, and homogenous of degree one.

Substituting E_{rsk} into E_V and rearranging yields:

$$E_V = V_F + P(E_O)[Q(E_X)\Delta - \Delta_F] \tag{1}$$

where $\Delta = V_H - V_L$, $\Delta_F = V_F - V_L$, and $Q(E_X)\Delta - \Delta_F > 0$. Eq. (1) includes two terms: V_F, the assets value when no risky loans are granted, and $P(E_O)[Q(E_X)\Delta - \Delta_F]$, the excess expected payoff due to risky loan grants. This excess payoff depends on $P(E_O)$, the proportion of risky assets chosen by top executives at the origination stage, and on $Q(E_X)\Delta - \Delta_F$, the excess return on a risky loan. This excess return equals the product of $Q(E_X)$—the quality of oversight (which is a function of executives' efforts)—and Δ—the potential gain from oversight efforts—minus the opportunity cost Δ_F (which is the profit foregone when risky loans end up with low payoff, V_L).

Executive j bears two kinds of nonmonetary costs:

1. She examines risky loans at a cost of $C(e_j^O + e_j^X)$, where $C(.)$ is a leisure cost function reflecting the disutility of work hours exerted in the origination and oversight stages.
2. She monitors other executives' efforts in the oversight stage. Recall that executives' efforts in the oversight stage are not observable to outsiders. Thus, internal monitoring by other executives is needed to eliminate shirking.

We assume that executive of rank j monitors (1) her single superior, (2) $k_j - 1$ equal-rank colleagues, and (3) k_{j-1} subordinates. As a result, executive j's own monitoring costs are $M(s_{-j})$, where $s_{-j} = \{k_{j-1}e_{j-1}{}^{X} + (k_j - 1)e_j^{X} + e_{j+1}{}^{X}\}$ is the expected efforts exerted by executive j on her "surrounding colleagues" monitoring.

The total compensation of top executives is composed of cash salaries and a proportional share of bank equity. Executive j's objective function is therefore:

$$E(W_j) = G_j + \alpha_j E_K - C(e_j^{O} + e_j^{X}) - M(s_{-j}) \tag{2}$$

where $E_K = E_V - \sum G_j - \text{Dep}(1+r) \geq 0$ is the expected accounting equity at Time 1, G_j is certain cash salaries paid to executive j at Time 1, $\text{Dep}(1+r)$ is the deposits value including accrued interest at Time 1, α_j is the proportion of total bank shares granted to executive j ($\sum \alpha_j \leq 1$), $C(.)$ is a leisure cost function (monotonically increasing with exerted efforts in both origination and oversight stages, homogenous, differentiable, and additive), and $M(.)$ is a leisure cost function similar to $C(.)$, except that it relates to the internal monitoring activity of executive j.

Monitoring in our model is crucial. In the absence of internal monitoring, each executive can be better off by promising maximum oversight effort (e^{X}) while actually exerting no effort at all. In order to avoid such equilibrium, the owner grants each executive incentives, α_j, a fraction of bank stocks. These incentives induce executives to exert more efforts on the job. Granting bank stocks to a top executive also gives him or her a stake in all other executives' efforts because the aggregate team effort determines the bank's value. This provides the basic economic rationale for each executive to monitor the other.

The owner objective is to maximize his or her expected profits: the owner's share in equity net of the initial investment, K_0:

$$E(W_P) = E_K\left(1 - \sum \alpha_j\right) - K_0 \tag{3}$$

The optimal compensation contract is obtained by solving the owner's objective function subject to all executives' behavior functions:

$$\max E(W_P)_{G_j,\alpha_j} \tag{4}$$

$$\text{s.t.} \qquad E(W_j) \geq G_j^{0} \qquad j = 1 \cdots n$$

where $G_j{}^{0}$ is the minimum salary executive j is willing to accept. In the solution, we use the following two assumptions (see Appendix A):

1. owner rationality — the owner is indifferent with regards to whom to grant the next share (α). At the margin, granting an additional stock to executive i or to executive j must yield the owner the same utility.
2. executive rationality — each executive equates all marginal personal costs with the expected marginal income.

From the solution of Eq. (4) (see Appendix B), we obtain:

$$M[\alpha_j] = \frac{E_K}{2k_j}[\alpha_j + \log(\frac{1-\delta_j}{1-\delta_j-\alpha_j})]$$

where k_j is the number of equal rank colleagues and δ_j is the equity share granted to executive other than executive j herself. As we assumed $1 \geq \delta_j + \alpha_j = \sum\alpha_j$, it can be easily seen that monitoring activity is positively correlated with executive j's incentive fees, α_j, as well as other executives' incentives, δ_j. In contrast, monitoring is a negative function of the number of colleagues. Thus,

Proposition 1: Internal monitoring among top executives is positively correlated with incentive pay and negatively correlated with the number of equal-rank colleagues.

Given Proposition 1, it is of interest to examine the differences in incentive pay between different rank executives. In Appendix C, we show that (Eq. (5)):

$$\alpha_j - \alpha_i = (2k_iM_i - 2k_jM_j)/T \tag{5}$$

where M_i is the derivative of the monitoring costs borne by the colleagues of executive i with respect to his or her oversight efforts (e_i^X), k_i is the number of executives of rank i, and $T = \partial E_K/\partial e_j^O + \partial E_K/\partial e_j^X = P'(E_O)(Q(E_X)\Delta - \Delta_F) + Q'(E_X)P(E_O)\Delta$ is the marginal contribution of executive j to the expected bank equity values (Appendix A).

The sign of $\alpha_j - \alpha_i$ is determined primarily by the typically large difference between k_i and k_j, where $k_i > k_j$ for $j > i$ because in each rank closer to the top there are fewer and fewer executives. The difference between M_i and M_j is probably small relative to the difference between k_i and k_j. Thus, most likely, $\alpha_j - \alpha_i > 0$, and

Proposition 2: Incentive pay (α) increases with executive rank.

Consider, for example, the CEO. In this case, $\alpha_{CEO} - \alpha_i = (2k_iM_i - M_{CEO})/T$ (see Appendix C), where k_i is the number of executives in the second tier just below the CEO. Because k_i is larger than 1, it is likely that $\alpha_{CEO} - \alpha_i > 0$, that is the CEO receives a higher fraction of bank value (more incentive pay) than lower rank executives. In general, the gap between the incentive pay of executive j and executive i (j being the higher rank) is positively correlated with the difference in the number of executives between the ranks, with higher rank executives collecting higher incentive compensation.

3. The regulatory constraints

In this section, we examine the effect of regulatory constraints on the equilibrium by introducing a supervisor of banks. The supervisor requires that the minimal bank equity should be a certain proportion of its risky assets. We assume that deposit insurance premiums transferred to the FDIC at Time 0 are deducted from the initial investment, K_0. According to the Basle Accord (1988), banks must maintain a minimum capital equal to 8% of their risk-weighted assets. In our framework, the CAD requirement implies that the expected equity (E_K) should be at least Z% of the bank's expected risk-weighted assets (E_V).

Let the CAD requirement be binding, i.e., assume the bank is undercapitalized at time $t_0(E_K/E_V < Z)$. To comply with the regulation, the bank must cut its risky loans, and executives' expected efforts in the origination stage decrease ($E_O^* < E_O$, where all variables under the CAD requirement appear with an asterisks). In response, bank executives and the owner will agree on a higher effort level at the oversight stage (E_X^*). The ratio E_X^*/E_X^* is denoted as χ, and $\chi > 1$.

Appendix D shows that Proposition 2 holds in a CAD environment too. For every $j > i$ in the organizational hierarchy of a bank subject to the CAD regulation, the incentive fees to executive j are larger than those of executive i. In addition, comparing the regulated bank α_j^* with the unregulated bank α_j (see Eqs. (D3) and (C1) in the appendices): $\alpha_j^* = 1 - 2\chi k_j M_j / T$, while $\alpha_j = 1 - 2k_j M_j / T$. Since χ, the ratio of postregulation to preregulation oversight-stage efforts of the executives is higher than 1, we conclude that $\alpha_j^* < \alpha_j$ and offer

Proposition 3: In banks subject to regulations such as the CAD requirement, executives receive less incentive pay (than in unregulated banks).

Proposition 3 is consistent with existing empirical evidence, such as Crawford et al. (1995) and Hubbard and Palia (1995), who found that bank CEOs' incentive pay increases following bank deregulation.

4. Conclusions

The paper examines the interrelation between incentive pay, monitoring, and regulatory requirements in banks. In a one-period model with asymmetric information between all players, we demonstrate that executives' incentive pay is positively correlated with their internal and mutual monitoring activity. Contrary to the common belief, incentive pay increases internal monitoring.

The model also provides a new perspective on why senior executives (and especially the CEO) collect more incentive pay than their subordinates do. As one climbs up the organizational pyramid, there are fewer executives to monitor her or him so the ability to shirk increases. In fact, the larger incentive payments to top executives are necessary not only to align their interests with those of the shareholders but also to encourage mutual monitoring activity.

Finally, we show that regulations such as the CAD requirement might reduce the incentive pay of executives. To the extent that this reduction in pay leads competent executives to leave (or not to enter) the banking industry, regulators are cautioned against the side effects of their actions.

Appendix A

A.1. Rationality

Differentiating the owners' objective function (Eq. (3)) with respect to α_j yields:

$$\partial E(W_\mathrm{P})/\partial\alpha_j = -E_\mathrm{K} + e_j^\alpha(1-\sum\alpha_i)(P_j'(E_\mathrm{O})(Q(E_\mathrm{X})\Delta - \Delta_\mathrm{F}) + Q_j'(E_\mathrm{X})P(E_\mathrm{O})\Delta) = 0$$

where, $P_j'(E_\mathrm{O}) = \partial P(E_\mathrm{O})/\partial(e_j^\mathrm{O})$ is the marginal influence of executive j on the bank assets mix (risky loans vs. safe assets), $Q_j'(E_\mathrm{X}) = \partial Q(E_\mathrm{X})/\partial(e_j^\mathrm{X})$ is the contribution of executive j to the expected value of the risky loans, and e_j^α is the derivative of executive j's both types of efforts with respect to α_j.

We assume, without loss of generality, that all top executives have the same contribution. Thus, $P_j'(E_\mathrm{O}) = P_i'(E_\mathrm{O}) = P'(E_\mathrm{O})$ and $Q_j'(E_\mathrm{X}) = Q_i'(E_\mathrm{X}) = Q'(E_\mathrm{X})$. Equating the derivatives of executive j with that of executive i while rearranging yield:

$$e_j^\alpha T = e_i^\alpha T = T^\alpha = E_\mathrm{K}/[1-\sum\alpha_j] \tag{A1}$$

where $T = T_\mathrm{O} + T_\mathrm{X}$ is the total marginal contribution of any executive to equity values and $T_\mathrm{O} = P'(E_\mathrm{O})(Q(E_\mathrm{X})\Delta - \Delta_\mathrm{F})$ is his or her contribution to the bank assets mix while $T_\mathrm{X} = Q'(E_\mathrm{X})P(E_\mathrm{O})\Delta$ is the contribution concerning the loans quality. From Eq. (A1), we obtain $e_j^\alpha = e_i^\alpha = e^\alpha$. This equality states that from the owner standpoint the next granted share has the same influence on executives' efforts, which in turn affect equity values regardless the identity of the executive receiver.

A.2. Marginal considerations

Equating each executive's direct nonmonetary costs, i.e., efforts related to both origination and oversight the borrowers with marginal income, yields:

$$\partial E(W_j)/\partial e_j^\mathrm{O} = 0 \Rightarrow \alpha_j[P'(E_\mathrm{O})(Q(E_\mathrm{X})\Delta - \Delta_\mathrm{F})] = \alpha_j T_\mathrm{O} = C_j^\mathrm{O}$$

$$\partial E(W_j)/\partial e_j^\mathrm{X} = 0 \Rightarrow \alpha_j[Q'(E_\mathrm{X})P(E_\mathrm{O})\Delta] = \alpha_j T_\mathrm{X} = C_j^\mathrm{X}$$

where C_j^O, C_j^X are the derivatives of executive j's leisure cost functions with respect to origination and oversight efforts, respectively. By incorporating both conditions, we obtain:

$$\alpha_j(T_\mathrm{O} + T_\mathrm{X}) = \alpha_j T = C_j^\mathrm{O} + C_j^\mathrm{X} \tag{A2}$$

Appendix B

The Lagrange function has the following form:

$$L = E(W_{\mathrm{P}}) + \sum_{j=1}^{n} \lambda_j [E(W_j) - G_j^{\mathrm{O}}] \tag{B}$$

Taking the derivatives of Eq. (B) with respect to $G_1,\ldots,G_n$, $\alpha_1,\ldots,\alpha_n$, and $\lambda_1,\ldots,\lambda_n$ yields the following equations (Eq. (B1)):

$$\partial L/\partial G_1 = -(1 - \sum \alpha_j) + \lambda_1 - \sum \lambda_j \alpha_j = 0 \Rightarrow \lambda_1 = 1 + \sum \alpha_j(\lambda_j - 1) \tag{B1}$$

$$\partial L/\partial G_n = -(1 - \sum \alpha_j) + \lambda_n - \sum \lambda_j \alpha_j = 0 \Rightarrow \lambda_n = 1 + \sum \alpha_j(\lambda_j - 1)$$

Since $\alpha_j > 0$, we obtain $\lambda_j = \lambda_i = 1$ for every j and i. So, the Lagrange can be presented in a reduced form, as follows:

$$L = E_{\mathrm{K}} - K_0 - \sum_{j=1}^{n} [C(e_j^{\mathrm{O}} + e_j^{\mathrm{X}}) + M(s_{-j}) + G_j^0]$$

$$= E_{\mathrm{K}} - K_0 - C\Big(\sum_{j=1}^{n} (e_j^{\mathrm{O}} + e_j^{\mathrm{X}})\Big) - M\Big(\sum_{j=1}^{n} s_{-j}\Big) - \sum_{j=1}^{n} G_j^0$$

where $C(.)$ reflects nonmonetary direct costs, i.e., efforts related to both origination and oversight, while $M(.)$ represents nonmonetary indirect costs, i.e., monitoring his or her colleagues.[1] Taking the derivative of L with respect to $\alpha_1,\ldots,\alpha_n$ yields:

$$\partial L/\partial \alpha_1 = e^{\alpha}[T_0 + T_{\mathrm{X}} - (C_1^{\mathrm{O}} + C_1^{\mathrm{X}}) - 2k_1 M_1] = 0 \tag{B2}$$

$$\partial L/\partial \alpha_n = e^{\alpha}[T_0 + T_{\mathrm{X}} - (C_n^{\mathrm{O}} + C_n^{\mathrm{X}}) - M_n)] = 0$$

According to Eqs. (A1) and (A2), we can rewrite Eq. (B2) as follows (Eq. (B3)):

$$0 = T^{\alpha}(1 - \alpha_1) - e^{\alpha} 2k_1 M_1] \Rightarrow \frac{E_{\mathrm{K}}}{2k_1} = M'[\alpha_1] \frac{1 - \sum_{j=1}^{n} \alpha_j}{1 - \alpha_1} = M'[\alpha_1]\Big(1 - \frac{Z_1}{1 - \alpha_1}\Big) \tag{B3}$$

$$= T^{\alpha}(1 - \alpha_n) - e^{\alpha} M_n] \Rightarrow E_{\mathrm{K}} = M'[\alpha_n] \frac{1 - \sum_{j=1}^{n} \alpha_j}{1 - \alpha_n} = M'[\alpha_n]\Big(1 - \frac{Z_n}{1 - \alpha_n}\Big)$$

[1] Referring the CEO (denoted by subscript $-n$), there are neither superior nor colleagues (except herself). Therefore, $S_{-n} = K_{n-1} e_{n-1}^{\mathrm{X}}$.

$$Z_j = \sum_{\substack{i=1 \\ i \neq j}}^{n} \alpha_i$$

where <1 is all other than executive j's incentive fees, which assumed to be irrelevant to executive j's direct efforts, and $M'[\alpha_j] = e^{\alpha} M_j$ is the derivative of monitoring costs of executive j's colleagues with respect to j's incentive fees. Solving these n differential equations for $M[\alpha_j]$ with the initial condition, $M[0] = 0$, gives the following equality for every $n > j > 1$:

$$M[\alpha_j] = \frac{E_{\mathrm{K}}}{2k_j}[\alpha_j + \log(\frac{1 - Z_j}{1 - Z_j - \alpha_j})] \tag{B4}$$

Note that for the CEO ($j = n$), $2k_j$ should be substituted with 1, as she is the only colleague (of herself) at that level. From Eq. (B4), one can easily seen that monitoring nonmonetary costs of executive j is positively connected to all executives' incentive fees — both others (Z_j) and herself (α_j) — but negatively related to the number of colleagues, k_j.[2]

Appendix C

From Eq. (B2), we obtain:

$$\partial L / \partial \alpha_1 = 0 \Rightarrow \alpha_1 = 1 - 2k_1 M_1 / T$$

$$\partial L / \partial \alpha_j = 0 \Rightarrow \alpha_j = 1 - 2k_j M_j / T \tag{C1}$$

$$\partial L / \partial \alpha_n = 0 \Rightarrow \alpha_n = 1 - M_n / T$$

Thus, equating the derivatives of executive j and i, where j is ranked higher than i, yields:

$$\alpha_j - \alpha_i = (2k_i M_i - 2k_j M_j) / T > 0$$

except for the CEO ($j = n$) where $2k_j$ should be substituted with 1.

Appendix D

The objective functions of both the owner (Eq. (3)) and the managers (Eq. (2)) in a bank subject to CAD requirements are the following:

$$E(W_j^*) = G_j^* + \alpha_j^* E_{\mathrm{K}}^* - \delta C(e_j^{\mathrm{O}} + e_j^{\mathrm{X}} - \chi M(s_{-j})$$

$$E(W_{\mathrm{P}}^*) = E_{\mathrm{K}}^*(1 - \sum \alpha_j^*) - K_0$$

[2] Organizational efficiency as well as other topics, such as whether these solutions are Pareto-optimal or Nash equilibrium, are beyond the scope of this paper.

where $E_K^* = E_K = V_F + \delta P(E_O)[\chi Q(E_X)\Delta - \Delta_F] - \sum G_j - \mathrm{Dep}(1+r)$ and asterisks denote parameters in a regulated banks. Taking the derivatives of both sides of the equality $E_K^* = E_K$ (i.e., bank equity has not changed) with respect to executives' efforts yields the conditions with regard to δ and χ as follows ($\chi > 1 > \delta$):

$$T^* = \partial E_K^*/\partial e_j^O + \partial E_K^*/\partial e_j^X = \delta P'(E_O)(\chi Q(E_X)\Delta - \Delta_F) + \chi Q'(E_X)\delta P(E_O)\Delta$$

As $T = \partial E_K/\partial e_j^O + \partial E_K/\partial e_j^X$, it means $T^* = T$ iff

$$\frac{\delta - 1}{\chi\delta - 1} = [Q(E_X) + \frac{P(E_0)Q'(E_X)}{P'(E_0)}]\frac{\Delta}{\Delta_F}$$

which in turn reflects the ratio between the increase in oversight efforts and the decrease in origination efforts. Since, the nominator in the LHS is negative while the RHS is always positive, we obtain a necessary condition for χ and δ: $1 > \chi\delta$. Otherwise, $T^* \neq T$. As in Appendix A, taking the derivatives of the owner's function with respect to incentive fees granted to executive j (α_j^*), yields the rationality:

$$e_1^{\alpha^*}T^* = e_n^{\alpha^*}T^* = E_K/[1 - \sum \alpha_j^*] \quad \text{(D1)}$$

where, all notations are similar to those in Appendix A except the asterisks. It is clear from Eq. (D1) and the equality between T^* and T that $e_n^{\alpha^*} = e_n^{\alpha} = e^{\alpha}$. From the "marginal considerations principle" (see Appendix A), we obtain (Eq. (D2)):

$$\delta C_j^{O^*} + \chi C_j^{X^*} = \alpha_j^* T \quad \text{(D2)}$$

Consequently, the Lagrange in its reduced form appears as:

$$L^* = E_K - K_0 - \sum_{j=1}^{n}[C(\delta e_j^O + \chi e_j^X) + M(s_{-j}^*) + G_j^0]$$

where, $s_{-j}^* = \chi\{k_{j-1}e_{j-1}^X + (k_j - 1)e_j^X + e_{j+1}^X\} = \chi s_{-j}$ is the expected oversight efforts from executive j's colleagues in a regulated bank. Again, the derivative of L^* with respect to $\alpha_1^*, \ldots, \alpha_n^*$ yields:

$$\partial L/\partial \alpha_1^* = e^{\alpha}[T - (\delta C_1^{O^*} + \chi C_1^{X^*}) - \chi 2k_1M_2] = 0$$

$$\partial L/\partial \alpha_n^* = e^{\alpha}[T - (\delta C_n^{O^*} + \chi C_n^{X^*}) - \chi M_n] = 0$$

According to the above two principles, we can rewrite the above equations, as follows:

$$0 = e^{\alpha}[T(1 - \alpha_1^*) - \chi 2k_1M_1] = e^{\alpha}[T(1 - \alpha_n^*) - \chi M_n]$$

Thus, equating the derivatives of executive j and i when j's ranking is higher than i yields:

$$\alpha_j^* - \alpha_i^* = \chi(2k_iM_i - 2k_jM_j)/T > 0 \Rightarrow \alpha_j^* > \alpha_i^*.$$

Furthermore, from Eq. (D3), we obtain $\alpha_j^* = 1 - 2\chi k_jM_j/T$, while according Eq. (C1), $\alpha_j = 1 - 2k_jM_j/T$. Thus, $\alpha_j^* < \alpha_j$ as $\chi > 1$.

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