

# Optimal Manager Compensation: A Multi-generation Dynamic Decision Model

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## ABSTRACT

*This paper proposes a Lagrangian dynamic decision model to solve the optimal and sub-optimal level of manager compensation. Such level maximizes the alignment of manager's and board's interests and minimizes the agency problem. The model considers five sources of manager income: current period monetary, future low uncertainty, future high volatility, current period non-monetary benefits from firm, and current period non-monetary title benefits from the business community. Under the recursive multi-generation dynamic assumption, I set up the agency's problem and the compensation constraint due to the threats of replacement and the vested payments. Then I provide the first order condition to identify the optimal level and the combination of manager's payment for each type of compensation.*

**Keywords:** *Manager Compensation,; Income, Executive, Optimal, Agency Problem, Dynamic Model*

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## INTRODUCTION

The agency problem, generally defined as the conflict of interest between the manager of the firm and the shareholders of the firm, is one of the mostly focused issues by the business community. A number of previous studies which are discussed in detail in section 2 attempts to address this issue, yet no research has been done to provide a quantitative model that can be directly utilized to guide the specific number to be paid to the manager. My paper therefore attempts to propose a Lagrangian dynamic decision model to solve the optimal and sub-optimal level of manager compensation. Such level maximizes the alignment of manager's and board's interests and minimizes the agency problem.

The actions undertaken by managers that generate conflict of interest between manager and shareholder including but not limit to abusing capital to expand the business in order to increase their job security and compensation; numerous and expensive perquisites; or investing in highly risky ventures. No matter what

actions cause the conflict, the nature of the deviation of interest roots from the heterogeneous goals: managers and shareholders maximize their own benefits, and the managers do not have to always maximize their interest by maximizing the firms' earnings.

Designing the optimal level of manager's compensation can maximize the manager's incentive to maximize the earnings of the firm. Carefully designed multi-generation manager compensation can maximize the manager's incentive to maximize the earnings of the firm in the long run. The initiatives of my study are first, to proof that the optimal compensation level exists; and second, to provide a quantitative guidance to firms when issuing the contract to the managers. Such guidance is necessary because in the real business world, the board of the firm faces many tradeoffs and dilemmas to align the manager's interest with proper amount of payments and type of payments. Some of these tradeoffs and dilemmas are:

First, if the major compensation to the manager is current period monetary assets, for example, cash

paychecks, or allowances, managers might easily locate themselves at the upper portion of the labor supply curve. At such portion, the tradeoff between leisure and income is significant. Managers tend to work less for the constant amount of remuneration.

Second, if the major compensation to the manager is future period low uncertainty monetary assets, for example, vested retirement benefit, or deferred bonus package, managers might focus on the security of their positions by adopting negative net present value projects. In such case, the goal of the managers switches from “doing a good job” to “stay”. Another negative impact is to discourage the managers from taking reasonable risk and expand the business, as managers avoid involving into any action that might expose their evaluation under uncertainty.

Third, in order to avoid the above-mentioned issues, the board can pay the major portion of the manager’s compensation in the form of granting common stocks. This might generate three potential problems: the manager might be very risk-averse and simply maintaining the stock price so as to maintain her earnings level; the manager might be encouraged to consider earnings management or manipulation actions; and to avoid the dilution of the equity that she is holding, the manager might risk the firm with inappropriately high leverage, so that the return of equity will be higher. From such perspective, a rational should not consider any seasoned or secondary equity offering (SEO), and the equity price structural break brought by the SEO is not optimal or sub-optimal for the firm or manager either.

Fourth, the board might grant more stock options, or adding the “Golden Parachute” clause in the contract instead of the common stocks to discourage the manager from being too risk adverse. Stock options do not have the downside risk for its holder and therefore the managers can focus on growing the equity value, rather than maintaining the stock price. Yet options might result in short run aggressive expansion activities pre- and post- the vested period of stock option. Meanwhile, options do not mitigate the earnings manipulation concerns, such as early recognition of revenue.

Therefore a quantitatively proofed optimal tradeoff relationship among various compensation types is necessary for the firms. My paper does not consider the conflicts of interests among other parties involved: board, large-stake shareholder, small-stake shareholders, etc. The concept of manager in the model can be used interchangeably with executives, or CEO.

## LITERATURE REVIEW

A number of past studies focus on the broad topic of aligning the interests of managers and board, assuming the board has no conflict of interest with the shareholders, and the conflict of interest among controlling and non-controlling shareholders are minor. Most of such studies empirically confirm the existence of the agency problem, for example, Kuang (2008). Some of such studies propose conceptual and qualitative frameworks, for instance, Chua, Chrisman, and Bergiel (2009). However, no previous literature directly offers a quantitative decision model of the optimal manager compensation level.

Previous studies (Brick, Palmon and Wald, 2012; Ozerturk, 2006) usually use pay-performance sensitivity (*PPS*) and the convexity of managerial compensation (*Vega*, or  $\nu$ ) as measures of the linkages between firm equity performance and managers’ income. The definitions are:

$$PPS = \frac{\partial I(\cdot)}{\partial p_e} \quad (1)$$

where  $I(\cdot)$  is the manager’s income, and  $p_e$  is the firm’s equity price.

$$\nu = \frac{\partial I(\cdot)}{\partial \sigma_e} \quad (2)$$

where  $I(\cdot)$  is the manager’s income, and  $\sigma_e$  is the firm’s equity return standard deviation.

Brick, Palmon, and Wald (2012) conclude that higher and higher Vega are associated with lower future stock returns. Ozerturk (2006) suggests that while managers privately hedge the risk in their compensation by trading in the financial markets, the manager’s optimal hedge depends on the liquidity of the market. Due to imperfect liquidity, the equilibrium *PPS* and hence the manager’s equilibrium incentives and the firm value increases in the liquidity of the market. My research considers more incentive types than the equity income and also considers the variables at a dynamic setting. Yet in terms of the common stock compensation, my study utilizes *PPS* and  $\nu$  as measures in consistent with the existing literatures.

Graham, Li, and Qiu (2012) decompose the variation in executive compensation and find that time invariant firm and especially manager fixed effects explain a majority of the variation in executive pay. This supports my three-source categorization of manager compensation: fixed payments, low volatility payment, and high volatility payment.

Chua, Chrisman, and Bergiel (2009) introduced the comparison of family and non-family firms and one of

their major contributions in terms of methodology framework is to consider the altruistic tendencies. I incorporate such consideration in my model. My study however provides the quantitative model and the optimal solution instead of the qualitative description concluded in Chua, Chrisman, and Bergiel (2009).

Brazel and Webb (2006) confirm the pecking order theory and suggest that should consider the ramifications of executive compensation structure when considering making an SEO. Similarly, Datta, Iskandar-Datta, and Raman (2005) document that when the managers' equity-based compensation are high, market perceives their SEOs are more-overvalued equity, benefiting existing shareholders and exacerbating the adverse selection problem for potential shareholders. My paper therefore introduces a structural break type of dynamic equity price series, in which the return of equity not only depends on the performance of the firm but also depends on the SEO timing.

Williams and Rao (2006) find that the ratio of post- to pre-merger stock return variance is positively related to the risk incentive effect of CEO stock option compensation but this relationship is conditioned on firm size, and smaller firms shows more significant size effect. However, Bhattacharyya, Mawani, and Morrill (2008) show that executive compensation is positively associated with earnings retention, and thus negatively associated with dividend payout. It is the retained earnings rather than size that matters in terms of manager compensation.

Kalyta (2009) reminds that while optimal contracting can align the interests of managers and shareholders, the impact of managerial power over boards on managerial pay can generate the deviation of compensation contracts from the optimum. The model in my study similarly considers the non-transparent and non-monetary type of compensation the manager receives from the board.

Ruiz-Verdú (2008) is the first research that quantitatively models the optimal level of shareholder power to maximize the firm value. However, the model takes the outsider perspective of the firm instead of the insider perspective of the manager.

Carpenter (2000) concludes that providing the manager more options will causes the manager to reduce volatility. Baglioni and Colombo (2009) also suggests that giving up option as a compensation tool is inappropriate. Dodonova and Khoroshilov (2006) agree that more option-based compensation should be used in firms with higher cash flow volatility and in industries with a higher degree of heterogeneity among firms. Based on this conclusion, I use options in my model as positive incentives similar to stocks.

Nickerson and Zenger (2008) propose the theory that focuses on social comparison costs that arise through social comparison processes and envy. This is consistent with my proposition that peer compensation should be involved to adjust the manager income.

Margiotta and Miller (2000) investigate managerial compensation and its incentive effects with a multiperiod principal-agent model with moral hazard. They find that while firms would incur large losses from moral hazard, managers only require moderate additional compensation for accepting a contract that aligns their interest with the firm. Their study empirically proves that the effort controlling managers' deviation actions need not involve infinite cost, and therefore supports my proposition of bounded compensation budget.

Sliwka (2002) argues that the reason managers focus on operational issues rather than financial issues is because financial performance measures strategic effort can only be rewarded in the future. I therefore propose the high uncertainty compensation category of the managers in consistent with Sliwka (2002). On contrast, Noe and Rebello (2012) indicate that increasing managers' stake in the long-run viability of the firm may ameliorate agency conflicts.

Kuang (2008) empirically confirms that performance-vested stock options can lead to managers' engaging in earnings management. This finding suggests the current model to propose a discount in terms of the high uncertainty income of the managers as this category generates deviation from the optimal agency problem solution. Ofek and Yermack (2000) draw similar conclusion that equity compensation succeeds in increasing incentives of lower-ownership managers.

## **THE MODEL**

I identify five sources of manager income: current period monetary, future low uncertainty, future high volatility, current period non-monetary benefits from firm, and current period non-monetary title benefits from the business community.

The current period monetary income,  $\tilde{C}_{t,t}^m$ , refers to the cash or cash equivalent compensation that the manager is promised at the current period that she will receive at the current period without any uncertainty. In other words, this category of income is not contingent to the performance of the firm. The future low uncertainty income,  $\tilde{I}_{t,t+1}^m$ , refers to the cash or cash equivalent compensation that the manager is promised at the current period that she will receive at the future

period contingent to the continuous hiring of the manager when the future benefit becomes current. As a low volatility term,  $\tilde{L}_{t,t+1}^m$  is regarded as a constant different from  $\tilde{L}_{t,t+1}^m$ .

I introduce the current period job security probability,  $p_{t,t+1}$ , to the model.  $p_{t,t+1}$  describes the probability that at period  $t$ , the manager still keeps her position at the next period. therefore stands for the probability that at period , the manager still keeps her position, which is a realized fact and thus the value is 1. Contracts are always forward-looking and only the discussion of is meaningful. Consistently, the term  $p_{t,t+1}\tilde{L}_{t,t+1}^m$  is the expected future low uncertainty income.  $\alpha_{t-1,t}$  and  $\beta_{t-1,t}$  are the allocated weights of  $\tilde{C}_{t,t}^m$  and  $\tilde{L}_{t-1,t}^m$  in the whole compensation package.

The aggregate future high volatility income,  $\gamma_{t,t+1}S_{t,t+1}^m + (1 - \gamma_{t,t+1})O_{t,t+1}^m$ , is the combination of income generated by the granted stock and option.  $S_{t,t+1}^m$  is the stock granted at this period and the value can be realized in the next period. As a highly volatile variable,  $S_{t,t+1}^m$  should not be considered as a constant  $\tilde{S}_{t,t+1}^m$ . Similarly,  $O_{t,t+1}^m$  is the option granted at this period and the value can be realized in the next period and it is also associated with high volatility.

$\gamma_{t,t+1}$  is a key variable with multiple functions. In terms of the aggregate future high volatility income, it is the weight of the stock granted. In other words,  $1 - \gamma_{t-1,t} - \alpha_{t-1,t} - \beta_{t-1,t}$  is the weight of the options granted. Considering the difference of impact induced from the stock and option granted,  $\gamma_{t,t+1}$  is also a measure of risk aversion. The higher the value of  $\gamma_{t,t+1}$ , the manager is less motivated to take operational risk and pursue earnings for the firm. If the value of  $\gamma_{t,t+1}$  equals 1, the manager is the least aggressive in terms of business expansion.

The current period non-monetary benefits from firm,  $\tilde{F}_{t,t}^{nm}$ , and current period non-monetary title benefits from the business community,  $\tilde{B}_{t,t}^{nm}$ , are the benefits that do not arrive at the manager's ownership as financial assets. However, such benefit can be converted into financial asset to some extent. Examples are the ability to allocate job and promotion for interest-related parties, social and media reputation, networking due to the position in the firm, etc. Such benefits can only be realized if the manager is currently hired.

Therefore the expected value of current income from these two sources is  $p_{t-1,t}(\tilde{F}_{t,t}^{nm} + \tilde{B}_{t,t}^{nm})$ .

To summarize, the lump-sum compensation the manager will receive from the firm is:

$$\begin{aligned} C_{t,t} = & \alpha_{t-1,t} \tilde{C}_{t,t}^m + \beta_{t-1,t} p_{t-1,t} \tilde{L}_{t-1,t}^m + \gamma_{t-1,t} S_{t-1,t}^m \\ & + (1 - \gamma_{t-1,t} - \alpha_{t-1,t} \\ & - \beta_{t-1,t}) O_{t-1,t}^m \\ & + p_{t-1,t} (\tilde{F}_{t,t}^{nm} + \tilde{B}_{t,t}^{nm}) \end{aligned} \quad (3)$$

where  $\alpha_{t-1,t} \in [0, 1]$ ,  $\beta_{t-1,t} \in [0, 1]$ ,  $p_{t-1,t} \in [0, 1]$ ,  $\gamma_{t-1,t} \in [0, 1]$ .

The goal of manager is to pursue the maximization of  $C_{t,t}$ . The budget constraint of the compensation is bounded by the retained earnings, and is affected by the horizontal comparison in the peer group of the industry which the firm is categorized in. Assume the industry includes  $n$  firms and each offers the lump-sum compensation  $\{C_{t,t}^1, C_{t,t}^1, \dots, C_{t,t}^n\}$ , I propose the following Proposition 1.

**Proposition 1:** If  $C_{t,t} < \max\{C_{t,t}^1, C_{t,t}^1, \dots, C_{t,t}^n\} - TR_{t,t}$ , then  $p_{t,t+1} = 0$ .

Here  $TR_{t,t}$  is the transit cost from the current company to the firm that offers the highest compensation. Proposition 1 excludes the personal or emotional loyalty and implies that the likelihood for the manager to stay in the current firm is 0 when switching to another company is profitable. Proposition 1 also sets the lower bound for the compensation to the manager.

The budget constraint for the manager is contingent to the earnings and equity performance of the firm. Ideally, the weight of current and future constant compensation to the manager,  $\alpha_{t-1,t}$  and  $\beta_{t-1,t}$ , should equal 0 to best align manager's interest. However, in reality this never occurs. The reasons are: first, the managers need basis income before the value of equity can be realized from the common share holdings and option holdings; second, the firm needs to prevent the earnings management incentive from growing beyond the acceptable level; third, a constant cash payment reduces the manger's over-aggressive actions and encourages the manager to cherish the current offer. Hence I propose Proposition 2.

**Proposition 2:** For  $\alpha_{t-1,t} = \mathcal{F}_1(AG_{t,t})$  and  $\beta_{t-1,t} = \mathcal{F}_2(AG_{t,t})$ ,  $\frac{\partial \mathcal{F}_1}{\partial AG_{t,t}} > 0$  and  $\frac{\partial \mathcal{F}_2}{\partial AG_{t,t}} > 0$

Here  $AG_{t,t}$  is the aggressiveness of the manager, and the weights of current and future constant compensation are functions of  $AG_{t,t}$ . The higher the manager's aggressiveness, the higher weight of compensation is allocated to constant payment. When the aggressiveness level is high, the firm no longer needs to encourage the active management from the manager. Instead, higher level of stock and option granted to an aggressive manager might lead to over-expansion and the adoption of negative net present value. The firm, facing an aggressive manager, needs to consider higher constant compensation to enhance the level of manager's caution by increasing her cost of failure.

On the contrary, when comparing the allocation of compensation to stocks and options, more aggressive managers should be granted less options. Call options carry asymmetric payoffs and have no downside risk. Therefore deep in the money or deep out of the money options encourage highly risky activities to boost the equity price and thus encourages moral hazard.

**Proposition 3:** For  $\gamma_{t-1,t} = \mathcal{F}_3(AG_{t,t})$ ,  $\frac{\partial \mathcal{F}_3}{\partial AG_{t,t}} > 0$ .

Here  $AG_{t,t}$  is the aggressiveness of the manager, and the weight of future stock compensation is a function of  $AG_{t,t}$ . The higher the manager's aggressiveness, the higher weight of compensation is allocated to future stock payment. In other words, according to Proposition 2 and 3, higher level of  $AG_{t,t}$  justifies higher levels of  $\alpha_{t-1,t}$ ,  $\beta_{t-1,t}$ , and  $\gamma_{t-1,t}$ ; thus the weight for options,  $1 - \alpha_{t-1,t} - \beta_{t-1,t} - \gamma_{t-1,t}$  is lower.

## CONCLUSION AND DISCUSSIONS

I set up the representative manager agent's problem in a dynamic scheme:

$$\begin{aligned} & \max_{\alpha_{t-1,t}, \beta_{t-1,t}, \gamma_{t-1,t}} \mathcal{C}_{t,t} \\ & s.t. \alpha_{t-1,t} = \mathcal{F}_1(AG_{t,t}) \\ & \beta_{t-1,t} = \mathcal{F}_2(AG_{t,t}) \\ & \gamma_{t-1,t} = \mathcal{F}_3(AG_{t,t}) \end{aligned} \quad (4)$$

where  $\mathcal{C}_{t,t} = \alpha_{t-1,t} \tilde{C}_{t,t}^m + \beta_{t-1,t} p_{t-1,t} \tilde{L}_{t-1,t}^m +$

$$\gamma_{t-1,t} S_{t-1,t}^m + (1 - \gamma_{t-1,t} - \alpha_{t-1,t} - \beta_{t-1,t}) O_{t-1,t}^m + p_{t-1,t} (\tilde{F}_{t,t}^{nm} + \tilde{B}_{t,t}^{nm}).$$

The optimal conditions are solved as the first order condition of the problem, given the assumption that  $\mathcal{C}_{t,t}$  is strictly concave:

$$\frac{d\mathcal{C}_{t,t}}{dAG_{t,t}} = 0 \Big|_{AG_{t,t} = AG_{t,t}^e} \quad (5)$$

The manager should present such a level of  $AG_{t,t} = AG_{t,t}^e$  to induce the firm to pay her the best combination of benefit. At this level, the firm can maximize its firm value.

My study takes the level of manager's aggressiveness as exogenous. In other word, I assume that there is no internal feedback mechanism to alter the initial level of risk appetite. However, this does not mean that the manager's aggressiveness is constant over time. The manager will adjust her level at every period upon observing the compensation structure and the operating status of the firm. The initial level of aggressiveness is beyond the range of discussion in my study, as this is at least a function of psychological factors, the experience of the manager, the corporate governance structure, and the regulatory body.

The next step of the research is to expand the agent's problem by adding more benefit related parties. The current model assumes that the board has no conflict of interest with the shareholders, and the conflict of interest among controlling and non-controlling shareholders are ignored. However, the optimal compensation might not be equal in terms of the board and various types of shareholders, if their conflicts of interest are present. Furthermore, two other roles can be considered when reaching the conclusion of manager's remuneration, which are the creditor and the regulator. Creditors face the tradeoff of motivating the manager to avoid default yet a high level of compensation induces default *per se*. In addition, the different tax brackets of income, either capital gain or dividends income, need to be justified.

## References

- [1] Baglioni, A., and Colombo, L. (2009), Managers' Compensation and Misreporting: A Costly State Verification Approach. *Economic Inquiry*, Vol.47, No.2, pp. 278-289.
- [2] Bhattacharyya, N., Mawani, A., and Morrill C. (2008). Dividend Payout and Executive Compensation: Theory and Evidence. *Accounting and Finance*, Vol. 48, No. 4, pp. 521-541.
- [3] Brazel, J. F., and Webb, E. (2006), CEO Compensation and the Seasoned Equity Offering Decision. *Managerial and Decision Economics*, Vol. 27, No. 5, pp. 363-378.
- [4] Brick, I. E., Palmon, O., and Wald, J. K. (2012), Too Much Pay-Performance Sensitivity? *The Review of Economics and Statistics*, Vol. 94, No. 1, pp. 297-303.
- [5] Carpenter, J. N. (2000), Does Option Compensation Increase Managerial Risk Appetite? *Journal of Finance*, Vol. 55, No.5, pp. 2311-2331.
- [6] Chua, J. H., Chrisman, J. J., and Bergiel, E. B. (2009), An Agency Theoretic Analysis of the Professionalized

- Family Firm. *Entrepreneurship Theory and Practice*, Vol. 33, No.2, pp. 355-372.
- [7] Datta, S., Iskandar-Datta, M., and Raman, K. (2005), Executive Compensation Structure and Corporate Equity Financing Decisions. *The Journal of Business*, Vol. 78, No. 5, pp. 1859-1890.
- [8] Dodonova, A., and Khoroshilov, Y. (2006). Optimal Incentive Contracts for Loss-Averse Managers: Stock Options versus Restricted Stock Grants. *The Financial Review*, Vol. 41, No. 4, pp. 451-482.
- [9] Graham, J. R., Li, S., and Qiu, J. (2012), Managerial Attributes and Executive Compensation. *The Review of Financial Studies*, Vol. 25, No.1, pp. 144-186.
- [10] Kalyta, P. (2009), Compensation Transparency and Managerial Opportunism: A Study of Supplemental Retirement Plans. *Strategic Management Journal*, Vol. 30, No.4, pp. 405-423.
- [11] Kuang, Y. F. (2008), Performance-Vested Stock Options and Earnings Management. *Journal of Business Finance and Accounting*, Vol. 35, No. 9-10, pp. 1049-1078.
- [12] Margiotta, M. M., and Miller, R. A. (2000), Managerial Compensation and the Cost of Moral Hazard. *International Economic Review*, Vol. 41, No.3, pp. 669-719.
- [13] Nickerson, J. A., Zenger, T. R. (2008), Envy, Comparison Costs, and the Economic Theory of the Firm. *Strategic Management Journal*, Vol. 29, No. 13, pp. 1429-1449.
- [14] Noe, T. H., and Rebello, M. J. (2012). Optimal Corporate Governance and Compensation in a Dynamic World. *The Review of Financial Studies*, Vol. 25, No. 2, pp. 480-521.
- [15] Ofek, E., and Yermack, D. (2000), Taking Stock: Equity-Based Compensation and the Evolution of Managerial Ownership. *Journal of Finance*, Vol. 55, No. 3, pp. 1367-1384.
- [16] Ozerturk, S. (2006), Managerial Risk Reduction, Incentives and Firm Value. *Economic Theory*, Vol. 27, No. 3, pp. 523-535.
- [17] Ruiz-Verdú, P. (2008), Corporate Governance When Managers Set Their Own Pay. *European Financial Management*, Vol. 14, No. 5, pp. 921-943.
- [18] Sliwka, D. (2002), On the Use of Nonfinancial Performance Measures in Management Compensation. *Journal of Economics and Management Strategy*, Vol. 11, No. 3, pp. 485-509.
- [19] Williams, M. A., and Rao, R. P. (2006), CEO Stock Options and Equity Risk Incentives. *Journal of Business Finance and Accounting*, Vol. 33, No.1-2, pp. 26-44.