The Determinant of the Executive Incentive Contract

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17th April 2008

Abstract

In this paper, I analyze the incentive contract and executive productivity from the classical viewpoint. Stock-based compensation as an incentive contract is paid for the management ability of the executive. In this sense, the executive with the higher management ability must be compensated with higher incentive pay and have a stronger incentive to maximize the shareholders’ interest, and as a result his own interest. I adopt the executive compensation model in Gabaix and Landier (2007) to calculate the tale index parameter $\beta_h$ and the return-to-scale parameter $\gamma_h$. Also, similar to Edmans, Gabaix and Landier (2008), I calculate I1, I2, and I3 as a measurement of incentives for executives. Based on the empirical evidence, I1 is the most efficient way to measure incentives and the highest return-to-scale executive CEO shows the highest incentive level among executives. The result also indicates that the COO and CFO who shows similar return-to-scale parameter have similar levels of incentive. The firm value enhancement purpose and the executive retention purpose play important roles behind the positive relation between incentive pay and management ability.

JEL Classification: D2, G30, J3

Keywords: Corporate Governance, Executive compensation, Production and Organization.

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1 Introduction

This paper analyzes the determinant of the executive incentive contract from the classical point of view. In this paper, the executive is compensated for both his talent and management ability which are matched with cash compensation and stock-based compensation, respectively. As the literature views stock-based compensation as an incentive pay, I show that the executive who has higher management ability receives higher incentive pay, and has a stronger incentive for higher productivity.

In the classical model, the worker’s compensation is decided in the equilibrium situation such that the marginal cost of labor (wage) equals the marginal product of labor. If we look at these supply and demand sides separately, we can match the component of an executive’s pay and his product. On the supply side, the executive has two kinds of abilities; one is a talent, and the other is a management skill. While the former is more likely to relate to his ability, the later is related to the characteristics of the firm. Just as no star player can be generated on his own, but rather by his team, an executive performance is partly based on the firm’s hierarchical structure, firm size, or other features of the firm\textsuperscript{1}. The executive’s decisions or tasks related to other workers influence the workers product and firm output, as well. In this sense, the executive’s product is based not only his talent but also on his management ability. On the demand side, executive compensation is commonly separated into two components; cash and stock. Cash is the fixed amount of money which is not correlated with the firm’s performance while, stock is valued by the firm’s performance. In this sense, stock-based compensation is regarded as an incentive contract.

Since stock-based compensation and the executive’s management ability is mainly influenced by the particular characteristics and structure of the firm, we can match each component of the executive’s ability and skill to each part of his compensation.\textsuperscript{2}

Now, it is worthwhile to ask the question: ‘What are the determining factors of the incentive contract?’, ‘How does the determinant affect to the executive incentive?’, and ‘Why does the firm make the relationship between the determinant and the executive

\textsuperscript{1}In theoretical model and empirical analysis, I will use the firm size as a firm feature to evaluate the executive’s management ability.

\textsuperscript{2}It is also true that the executive’s talent is related to the stock-based compensation. However, the product created by the talent must pay to executive under poor performance from the classical viewpoint. In this sense, the talent is more likely to be related with cash compensation.
incentive?’ Previously, Demsetz and Lehn (1985) and Smith and Watts (1992) explored those questions.

Demsetz and Lehn (1985) analyze the impact of the firm size and of the monitoring effectiveness on the managerial equity ownership. They use the market value of the firm equity as the proxy of the firm size and the instability measurement\(^3\) of the firm environment as the proxy of the monitoring effectiveness. The main findings of the paper are the positive relationship between instability measurement and managerial equity ownership and the negative relationship between firm size and the managerial equity ownership. They also argue that there is a value-maximizing firm size which is determined by the industry and by the variation between product and input markets.

Smith and Watts (1992) explore the effect of the firm’s investment opportunity and the firm size on the incentive compensation plan. They used the inverse price-to-book ratio\(^4\) as the proxy of the firm’s investment opportunity, the percentage of stock-option plan as the proxy of the incentive compensation plan, and the median sale in the same industry as the proxy of the firm size. They hypothesize that the more opportunities to invest the firm have, the more difficult to monitor the manager’s behavior. Based on the empirical analysis, they found the firm with higher investment opportunity is more likely to use the incentive compensation plan. Also, the hypothesis that the decentralization of the larger firm induces the use of the incentive compensation plan more frequently is supported by the positive relationship between firm size and incentive compensation plan in the regression result.

To answer the questions, I adopt the executive compensation models from Gabaix and Landier (2007) and Edmans, Gabaix and Landier (2008), respectively, to calculate the executive’s management ability and incentive. The estimations show that a high management ability executive has a strong incentive. Then, I explain how the firm’s value enhancement purpose and the executive’s retention purpose play an important role in the incentive pay and the management ability.

This paper makes two contributions. First, this paper attempts to understand the executive incentive contract based on the executive productivity. In much of the previ-

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\(^3\)They used three measurements: standard error which is calculated from the regression of the firm’s average monthly return on the average monthly return on value-weighted market portfolio, standard deviation of monthly stock rate of return, and standard deviation of annual accounting rate of return.

\(^4\)The higher inverse price-to-book ratio means the lower investment opportunity of the firm.
ous literature, an incentive contract\textsuperscript{5} is assumed to be the solution of the moral-hazard agency model to solve principal-agent problem. However, in this paper, the marginal product induced from his management ability is the main determinant of his incentive compensation. Also, the viewpoint of executive compensation is different from the articles which analyze the growth of CEO compensation based on the corporate governance system\textsuperscript{6} and managerial entrenchment\textsuperscript{7}. It is interesting to ask why CEO pay is more than twice that of those executives below CEO in some firms. This paper gives an answer that the higher management ability of the CEO is the key to the compensation gap. Comparing ability and compensation design among executives has rarely been studied.

This paper is then organized as follows. In section 2, I introduce related literature and explain modeling briefly. Section 3 shows the theoretical model and Section 4 presents the empirical strategy to estimate the executives’ management ability and their incentives. In Section 5, I explain implications from the estimation. Section 6 is the conclusion.

\section{Modeling and Related Literature}

Rosen (1992) proposes that the executive compensation model is based on the idea that each executive’s product is the interaction between talent and the productivity of control. He assumes that workers can obtain higher productivity by higher manager’s activity. In this sense, executive compensation is composed of the constant wage and the additional product from those workers connected with him as well as how firm’s hierarchical structure produces a ‘chain letter-like effect.’

Edmans, Gabaix and Landier (2008) suggest three different kinds of measurement of both pay-performance sensitivity and wealth-performance sensitivity, respectively in market equilibrium through the simple competitive assignment model and the executive compensation model. Those estimations have been used often to estimate the incentive strength or level of the incentive payment. One of the measurements, the dollar change of the executive wealth for a percentage change in firm value scaled by compensation, is invariant across firm size, which is useful as an incentive measurement for empirical

\textsuperscript{5}Oyer (2004), Lazear (2003) and Oyer and Schaefer (2005) argue the incentive mechanism of the executive compensation.

\textsuperscript{6}Look at Core and Larcker (1999), Gabaix and Landier (2007), Hermelin (2005).

\textsuperscript{7}Managerial entrenchment is studied by Bebchuk and Fried (2003), Bebchuk and Fried (2004), and Bertrand and Mullainathan (2001).
analysis.

In this paper, I assume that the level of the chain letter-like effect decided by each executive’s management ability is the principal determinant of the executive incentive contract. As a proxy of management ability, we can think about return on three firm characteristics: number of workers, firm hierarchical structure, and firm size. I will use the firm size among the firm characteristics\(^8\). Thus, management ability is estimated by each executive’s return to scale parameter with respect to firm size. To calibrate each executive’s return to scale parameter, I have adopted the compensation model from Gabaix and Landier (2007). It is worthwhile to compare the return-to-scale parameter and the strength of the incentive compensation among executives. However, executives counts not only the incentive payment, but also the stock of the firm, as his own wealth. I need to compare the strength of the incentive based on each executive’s wealth. Then, I can answer whether the higher management ability executive has a stronger incentive to maximize the shareholder’s interest, and as a result his own interest.

3 The Model

3.1 Executives’ Ability and Compensation

Gabaix and Landier (2007) suggest the basic model for executive compensation. They assume that: (1) managerial impact on earning depends on the size of a firm under their control; (2) each manager’s production function has the homogeneous "return to scale" parameter, \( \gamma \); (3) the talent space for each manager follows the extreme value distribution with a homogeneous tale index, \( \beta \); (4) the size of a firm has a Pareto distribution with a tale index \( \alpha \); and (5) managerial talent is allocated in a competitive market. The firm hires \( h \) executives with quality level \( q_h \). The executive \( h \) impacts the earning of firm by:

\[
a_1 = a_0 + C_h q_h (a_0)^\gamma
\]

where \( a_0 \) is the baseline earning of the firm depending on the firm’s assets at \( t = 0 \), and \( C_h \) is the effect of talent. Based on above equation, the firm hires \( h \) executive in a

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\(^8\)This is based on Garicano and Rossi-Hansberg (2006) which suggest that more talented people hold higher position in the firm because the impact of talented workers increases in the size of resource under their authority.
perfectly competitive talent market to maximize:

$$\max_{q_h} S^\gamma C_h q_h - W(q_h)$$

where $S$ is the size (value) of a firm, $\gamma$ is the "return to scale" parameter in the production function, and $W(q_h)$ is the wage of an executive with talent level $q_h$. Above equation shows the validity of the model with the executive ability and productivity assumption in that the firm’s product is based on the executive talent($C_h q_h$) and management ability($S^\gamma$).

Based on Gabaix and Landier (2007) (Propositions 2 and 6), compensation of $h$ executive in $n$ firm is given by$^9$,

$$w(n)_h = D(n^*) S(n^*)^{\frac{\beta_h}{\alpha}} S(n)^{\gamma - \frac{\beta_h}{\alpha}}$$

The main determinants of the executive pay are the size of a firm $S(n)$ and of a reference firm $S(n^*)$.

Now, we allow a "heterogeneous return-to-scale" parameter, $\gamma_h$ in the production function of each executive, and a "heterogeneous tale index" parameter $\beta_h$, in the extreme value talent space. Then, the pay of executive $h$ in $n$ firm is given by:

$$w(n)_h = D(n^*) S(n^*)^{\frac{\beta_h}{\alpha}} S(n)^{\gamma_h - \frac{\beta_h}{\alpha}}$$

Now, we can make predictions as follows;

1. Cross-sectional prediction: The pay of each executive varies with the size of a firm according to $S(n)^{\gamma_h - \frac{\beta_h}{\alpha}}$. This implies that "pay elasticity with respect to size" varies across the executives within a firm.

2. Cross-sectional prediction: Also, the pay of each executive varies with the size of a reference firm according to $S(n^*)^{\frac{\beta_h}{\alpha}}$. This implies that "pay elasticity with respect to size of a reference firm" varies across the executives within a firm.

$^9$In appendix A, there is a brief explanation about theoretical model based on Gabaix and Landier (2007)
### 3.2 Incentive Measurements of Executive

Edmans, Gabaix and Landier (2008) suggest the use of the partial equilibrium CEO compensation model. They assume that: (1) the CEO is risk-neutral; (2) the CEO chooses effort levels between $\kappa$ and $\kappa'$; (3) the CEO is compensated with cash and shares; (4) firm size is estimated by its equity, and; (5) unit cost of effort will differ across firms.

The CEO’s realized compensation in firm $n$ is

$$c(n) = w(n)(1 + \Lambda_n(r(n) - E[r(n)]))$$

where $\Lambda_n$ is the unit cost of effort in firm $n$, $w(n)$ is an expected wage in firm $n$, and $r(n)$ is the firm’s stock market return. Based on the Edmans, Gabaix and Landier (2008) (Proposition 2 and 3), equilibrium pay-performance sensitivities are defined in 3 ways\(^{11}\),

\[
\begin{align*}
    i_1 &= \frac{\partial c}{\partial r} \frac{1}{w} = \Lambda \\
    i_2 &= \frac{\partial c}{\partial r} \frac{1}{S} = \Lambda \frac{w}{S} \\
    i_3 &= \frac{\partial c}{\partial r} = \Lambda w
\end{align*}
\]

where $S$ is the firm’s market capitalization.

The CEO has an incentive to exert appropriate effort not only for his compensation but also by his wealth ($W$) in the firm. Thus, Edmans, Gabaix and Landier (2008) show wealth-performance sensitivity\(^{12}\) under the assumption that the proportion of own-firm financial wealth to total wealth is constant across firm size such that

\[
\begin{align*}
    I_1 &= \frac{\partial W}{\partial r} \frac{1}{w} = \Lambda \frac{W}{w} \\
    I_2 &= \frac{\partial W}{\partial r} \frac{1}{S} = \Lambda \frac{W}{S} \\
    I_3 &= \frac{\partial W}{\partial r} = \Lambda W
\end{align*}
\]

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\(^{10}\) In appendix B, there is a brief explanation about theoretical model based on Edmans, Gabaix and Landier (2008).

\(^{11}\) They assume $\Lambda_n = \Lambda$ in order to simplify the model.

\(^{12}\) Since incentive measurements have executive wealth in denominator, richer executive will have more incentive.
Now, I add an assumption that each executive has a different unit cost of effort ($\Lambda_h$), then, the incentive measurement of each executive $h$ is,

\[
I_1^1 = \frac{\partial W_h}{\partial r} \frac{1}{w_h} = \Lambda_h \frac{W_h}{w_h}
\]
\[
I_2^2 = \frac{\partial W_h}{\partial r} \frac{1}{S} = \Lambda_h \frac{W_h}{S}
\]
\[
I_3^3 = \frac{\partial W_h}{\partial r} = \Lambda_h W_h
\]

Now, we can make a prediction as follows:

1. $I_1^1$ is independent of the firm size;
2. $I_2^2$ varies with the size of the firm according to $S(n)^{(\gamma_h - \frac{\partial h}{\alpha} - 1)}$, and varies with the size of the reference firm according to $S(n^*)^{\frac{\partial h}{\alpha}}$;
3. $I_3^3$ varies with the size of the firm according to $S(n)^{(\gamma_h - \frac{\partial h}{\alpha})}$, and varies with the size of the reference firm according to $S(n^*)^{\frac{\partial h}{\alpha}}$;

4 Empirical Analysis

In this section, I will calculate the tale index parameter $\beta_h$ and the return-to-scale parameter $\gamma_h$ for CEOs, COOs, and CFOs. Then, I will show that the incentive measurement is higher for the higher return-to-scale parameter executive.

4.1 Calibration of the tale index parameter $\beta_h$ and return-to-scale parameter $\gamma_h$

To investigate executives' management ability and incentive contracts, I collected the data for CEOs, COOs, and CFOs from firms which are in the major S&P Index (S&P 500, Midcap, Smallcap) in 2005\(^{13}\). I first collected whole executives' data for the 1500 firms during 1992-2005. I focused on CEOs, COOs, and CFOs in order to collect sufficient data. CEO was identified by the annual CEO flag (CEOANN). COO and CFO were collected based on the annual title (TITLEANN). The executive who had multiple titles

\(^{13}\text{I also collect the data about the firms which have included at least once in major S&P Index during 1992-2005. However, data is not significantly different with 2005's.}\)
was classified according to the higher position\textsuperscript{14}.

\textit{Table 1}

Also, for firm size variables, market capitalization\textsuperscript{15} was collected from the Compustat ExecuComp Database. As a reference firm (\(n^*\)) size, I measured two different variables. The first \(S(n^*)\) is estimated by the upper 75th percentile firm market capitalization in each year\textsuperscript{16}. The other \(S(n^*)\) is estimated by the upper 75th percentile firm market capitalization in the same S&P index for the same years\textsuperscript{17}.

Based on equation (1), the empirical specifications for executive \(h\) compensation is given by:

\[
\ln w_h = b + \phi_1 \ln S(n^*) + \phi_2 \ln S(n) + \epsilon
\]

where \(\phi_1 = \frac{\beta_h}{\alpha}\) and \(\phi_2 = (\gamma_h - \frac{\beta_h}{\alpha})\)

\textit{Table 2}

In table 2, as I expected, the size of a firm (market capitalization) and of a reference firm explained each executive’s pay. Also, in the regression of CEO pay, Walds test showed that \(\phi_1 + \phi_2 = \gamma_{ceo} = 1\textsuperscript{18}\), which was consistent with Gabaix and Landier (2007).

Based on the theoretical model, the regression of the compensation on market value, and the reference firm’s market value, we can calibrate the heterogeneous return-to-scale parameter, \(\gamma_h\) as well as the tale index of the talent space, \(\beta_h\textsuperscript{19}\).

\textit{Table 3}

\textsuperscript{14}Since this data collection needs to calibrate the return-to-scale parameter of each executive based on their title, the those who have more than one title are more likely to have higher ability, so thus higher position. Based on the data, executive compensation (TDC1), executives are ordered like CEO > COO > CFO.
\textsuperscript{15}To calculate market capitalization of the firm, I use the same method in Gabaix and Landier (2007) which is the end-of-year share price (data199)* common shares outstanding (data25) + total asset (data6) - total common equity (data60) - deferred taxes in balance sheet (data74).
\textsuperscript{16}This estimation is the same method as Gabaix and Landier (2007) used in their paper. We can easily check the consistency of the data and calibration with their paper.
\textsuperscript{17}It is reasonable to think that the reference firm is decided by similar firm size. This variable may gives more precise calibration about the \(\beta_h\) and \(\gamma_h\).
\textsuperscript{18}This is only about regression with marcap75 without firm fixed effect and with sp75 with firm fixed effect.
\textsuperscript{19}Following Gabaix and Landier (2007), we adopt \(\alpha = 1\), when we calculate \(\gamma_h\) and \(\beta_h\).
Table 3 shows the estimated value of the parameters. The estimation indicates that the CEO’s return-to-scale parameter is greater than the COO’s or the CFO’s. However, the COO and CFO show similar return-to-scale levels.

Proposition 1. The highest management ability executive CEO will have the strongest incentive.

Proposition 2. The COO and CFO who show a similar level of return-to-scale parameter will have a similar level of incentive strength.

We will prove the above propositions after estimating the incentive level.

Now, we can make a prediction about executive incentive and firm size. We will use the parameter value of the regression with sp75 and with the firm fixed effect\textsuperscript{20}.

\[
\begin{align*}
I_{1\text{CEO}}^{1} & \propto S^{0}, \quad I_{1\text{COO}}^{1} \propto S^{0}, \\
I_{2\text{CEO}}^{2} & \propto S^{-0.66}, \quad I_{2\text{COO}}^{2} \propto S^{-0.66}, \\
I_{3\text{CEO}}^{3} & \propto S^{0.34}, \quad I_{3\text{COO}}^{3} \propto S^{0.34}
\end{align*}
\]

\(A \propto B^{p}\) means that \(A\) varies with \(B^{p}\)

where \(p\) denotes the elasticity of \(A\) to \(B\)

It seems interesting that the elasticity of each incentive to firm size is similar across executives.

4.2 Incentive Measurement

Based on a theoretical background, we can translate the measurements and calculations of each incentive as follows. \(I_{1}^{h}\) indicates the dollar increase in \(h\)’s wealth in the firm for each dollar increase in his compensation. \(I_{2}^{h}\) indicates the dollar increase in the wealth of the executive in the firm for each $1,000 increase in shareholder value. \(I_{3}^{h}\) indicates the dollar value of the shares which the \(h\) owns. Following these definitions, I calculated

\textsuperscript{20}The parameter value with sp75 and with firm fixed effect is selected to show the quantitative measurement because it indicates the similar result with Gabaix and Landier (2007). However, the other parameter values also show similar qualitative measurement about executive incentives.
each executive’s incentive (In appendix C, measurements are explained in detail),

\textit{Table 4}

The summary statistics of the incentive estimation, reported in Table 4 are consistent with our prediction that the higher management ability executive has higher level incentives. If we look at the median of executive incentives, CEO’s are obviously greater than COO’s or CFO’s, while COO’s and CFO’s are difficult to distinguish. Thus, we can prove Proposition 1 and Proposition 2. It is also important to figure out which incentive measurement is the most appropriate to analyze. Our model predicts that $I_{h}^{1}$ is the best measurement in that it is independent of firm size (The elasticity of the incentive to firm size is 0). We can check this prediction by regression of incentives on the firm size.

\textit{Table 5}

Table 5 illustrates the regression results. In Panel A, the regression results with firm fixed effect is consistent with the results of Edmans, Gabaix and Landier (2008) as well as our prediction. The regression results in Panel B and in Panel C cannot clearly duplicate our prediction; however, the results show that $I_{h}^{1}$ has the smallest elasticity for the firm size. Thus, we can conclude that $I_{h}^{1}$ is the best measurement of incentive and, therefore, Proposition 1 and 2 are proved.

5 Implication

It is worthwhile to compare incentive strength to wealth despite the caveat that an executive’s wealth is an important part in the incentive measurement. To calculate the impact of the incentive, we follow the assumption by Edmans, Gabaix and Landier (2008) that (1) executive wealth is the four times greater than his wealth in the firm\footnote{The executive wealth in the firm is the half of his financial wealth. And his human wealth is almost equal to his financial wealth.}, (2) $\varepsilon \simeq -10\%$. If executive $h$ shirks his responsibilities, his utility increases by a fraction $A_h |\varepsilon|$ and firm value decreases by a fraction $|\varepsilon|\%$. To calculate $A_h$, I use the median
value of the median $I^1_h$ in each year as a representative incentive.

\[ I^*_{CEO} = 7.26 \text{ (Median } I^1_{CEO} \text{ in 2000)} \]
\[ I^*_{COO} = 4.46 \text{ (Median } I^1_{COO} \text{ in 2001)} \]
\[ I^*_{CFO} = 3.84 \text{ (Median } I^1_{CFO} \text{ in 2000)} \]

Using the median value of $\frac{W_h}{w_h}$ and $\Lambda_h|\epsilon| = \frac{w_h}{W_h} |\epsilon|$, we can calculate $\Lambda_h|\epsilon|$

\[ \Lambda_{CEO}|\epsilon| = 0.0263 \]
\[ \Lambda_{COO}|\epsilon| = 0.0247 \]
\[ \Lambda_{CFO}|\epsilon| = 0.0248 \]

The above calculation implies that: (1) if the CEO shirks his responsibility, his utility increases by an amount to 2.63% of his wealth; (2) if the COO shirks his responsibility, his utility increases by an amount to 2.47% of his wealth, and; (3) if the CFO shirks his responsibility, his utility increases by an amount to 2.48% of his wealth.\(^{22}\)

Based on the Calibration of the return-to-scale parameter $\gamma_h$ in Table 3 and the incentive measurement in Table 4, we can answer our main question that the executive with higher management ability has a strong incentive. There is a great deal of literature about why firms use incentives. Jensen and Murphy (1990) argues that we need high pay-performance sensitivity\(^{23}\) to mitigate the conflict of interest between CEO and shareholders. Lam and Chng (2006)\(^{24}\) point out the firm value enhancement purpose of the stock option. Oyer (2004) and Lazear (2003) concentrate on the retention purpose of the stock option grant. Oyer and Schaefer (2005) investigate why firms might engage in broad-based stock option plans and conclude that options have the effect of increasing the cost to employees leaving the firm since options granted to employees by the firm

\(^{22}\)These implications only account for the executives’ wealth without change of firm value. If we consider the impact of executive misbehavior to firm value, the private benefit from shirking will be lower than our calibration.

\(^{23}\)Jensen and Murphy (1990) calculate pay-performance sensitivity which equals to 0.00325 from the observed contracts. However, they argue that this small observed pay-performance sensitivity is not implied by the formal principal agent model.

\(^{24}\)They find empirical implication that firms grant stock option for their value enhancement incentives to reduce agency costs and these indeed have value implications for the firm performance.
typically have a vesting period attached. We can explain our empirical results by firm value enhancement purposes and executive retention purposes. Since the executive with the higher management ability will have greater managerial power and greater impact on the firm’s performance, the firm is more likely to deter his shirking of duties and responsibilities. And any turnover of executive with higher management ability will induce a higher cost, such as the cost of replacing the executive, the loss of specific human capital acquired during the executive’s working period, and other costs. Since the executive with the higher ability has a powerful impact on the firm, the board will exert more effort, which generates more costs. These two reasons support our main question and the empirical result.

6 Conclusion

This paper has analyzed the relationship between the executive compensation contract and the executive’s ability. I matched the incentive contract to the executive’s management ability and analyzed whether the executive with higher management ability has a stronger incentive. To answer this question, I adopted the compensation model from Gabaix and Landier (2007) and Edmans, Gabaix and Landier (2008), then, calculate incentive level and the executive’s return to scale parameter with respect to firm size as the proxy of the executive’s management ability. The empirical work shows that the higher management ability executive (CEO) indicated a strong incentive level and CFOs and COOs showed a similar return-to-scale parameter and, as a result, showed similar levels of incentive. The executive retention purpose and firm value enhancement purpose, respectively, play an important role between executive ability and the incentive contract. In this paper, the primary role of the incentive contract is no longer the solution of the principal-agent problem, but serves as the compensation for the executive’s productivity.

For further research, the firm’s hierarchical structure can be used instead of firm size when we estimate executive management ability. The chain letter-like effect will have a different impact on the productivity related to executive management activity according to different firm hierarchical structures.
References


7 Appendix

7.1 Appendix A : Theoretical Model from Gabaix and Landier (2007)

This is a brief summary of propositions 2, 4, and 6 in Gabaix and Landier (2007).

The firm’s maximization problem,

\[
\max_h CS(n)^\gamma q(h) - w(h)
\]

- \(C\) – Effect of Talent on Earnings
- \(S(n)\) – Size of Frim \(n\)
- \(\gamma\) – Return to Scale Parameter
- \(q(h)\) – Talent of Executive \(h\)
- \(w(h)\) – Wage of Executive \(h\)
From the first order condition for the maximization problem,

\[ w'(h) = CS(n)^\gamma q'(h) \]

In equilibrium, there is an assortative matching, \( h = n \). Thus,

\[ w'(n) = CS(n)^\gamma q'(n) \]

Thus, \( W(n) \) is,

\[
W(n) = - \int_n^N CS(v)^\gamma q'(u)dv
\]

With the assumption of a Pareto firm size distribution with exponent \( \frac{1}{\alpha} \),

\[ S(n) = An^{-\alpha} \]

With the assumption that each manager follows the extremum value distribution with a homogeneous tale index, \( \beta \),

\[ q'(n) = -Bn^{\beta-1} \]

Executive compensation can be expressed by:

\[
W(n) = - \int_n^N A^\gamma BCv^{-\alpha\gamma+\beta-1}dv
\]

\[ = \frac{A^\gamma BC}{\alpha\gamma - \beta} [n^{-(\alpha\gamma-\beta)} - N^{-(\alpha\gamma-\beta)}] \]

\[ = \frac{A^\gamma BC}{\alpha\gamma - \beta} n^{-(\alpha\gamma-\beta)} \]

The last equality is from considering very large firm domain.

Executive compensation can be converted to the function of firm size.
\[
W(n) = \frac{A^\gamma BC}{\alpha \gamma - \beta} n^{-(\alpha \gamma - \beta)}
\]
\[
= \frac{1}{\alpha \gamma - \beta} CB(n^*)^\beta [A(n^*)^{-\alpha}]^\beta /\alpha [A(n^*)^{-\alpha}]^{(\gamma - \beta) / \alpha}
\]
\[
= -\frac{Cn^*q'(n^*)}{\alpha \gamma - \beta} S(n^*)^{\beta / \alpha} S(n)^{(\gamma - \beta) / \alpha}
\]
\[
= D(n^*) S(n^*)^{\beta / \alpha} S(n)^{(\gamma - \beta) / \alpha}
\]
where \(n^*\) is the reference firm index
and \(D(n^*) = -\frac{Cn^*q'(n^*)}{\alpha \gamma - \beta}\)

### 7.2 Appendix B: Theoretical Model from Edmans, Gabaix and Landier (2008)

This is a brief summary of the CEO compensation model in partial equilibrium from Edmans, Gabaix and Landier (2008).

Executive’s objective function,

\[
U = E[cg(e)]
\]

Where \(c\) is the executive’s monetary compensation
\(e \in \{\underline{e}, \bar{e}\}\) which is executive effort level

We can normalize as:

\[
\bar{e} = 0 > \underline{e}
\]

\[
g(\bar{e}) = 1
\]

\[
g(\underline{e}) = \frac{1}{1 + \Lambda \underline{e}}, \text{ where } \Lambda \in [0, 1)
\]

\(\Lambda\) is the unit cost of effort

The initial stock price is \(P\), and the end-of-period stock price is,

\[
P_1 = P(1 + \eta)(1 + e)
\]
where $\eta$ is stochastic noise with mean 0.

The CEO compensation $c$ is,

$$c = f + vP_1$$

where $f$ is the fixed cash salary and $v$ is the number of shares.

Based on Proposition 1 in Edmans, Gabaix and Landier (2008), the optimal contract pays a fraction $\Lambda$ of the wage in shares, and the rest in cash. Thus, in equilibrium,

$$f = w(1 - \Lambda)$$

$$vP = w\Lambda$$

Thus the CEO compensation $c$ is,

$$c = w(1 - \Lambda E[P_1/P]) + w\Lambda \left(\frac{P_1}{P}\right)$$

$$= w\{1 + \Lambda \left(\frac{P_1}{P} - E\left[\frac{P_1}{P}\right]\right)\}$$

$$= w\{1 + \Lambda \left(\frac{P_1}{P} - 1 - E\left[\frac{P_1}{P} - 1\right]\right)\}$$

$$= w\{1 + \Lambda (r - E[r])\}$$

where $r = \frac{p_1}{P} - 1$, which is firm’s stock market return.

### 7.3 Appendix C: Calculation of the Incentive

To calculate executive incentives, I adopt similar definitions from Edmans, Gabaix and Landier (2008). As specified, the incentive measurements are defined three different ways (I1, I2, and I3). Numerically, I1 and I2 can be expressed by I3 such that

$$I_1 = \frac{I_3}{\text{compensation}}$$

$$I_2 = \frac{I_3}{\text{marcap}}$$

where marcap is the market capitalization of the firm.

From calculating I3, we can also measure I1 and I2.
Since I3 is the dollar value of the share, it can be calculated such that:

\[ I3 = \text{value of the shares the executive owned} \]
\[ + \text{value of the newly granted restricted stock} \]
\[ + \text{value of the newly granted option} \]
\[ + \text{value of the unexercised exercisable option} \]
\[ + \text{value of the unexercised unexercisable option} \]

I used Compustat with ExecuComp(1992-2005) and selected the firm in the major S&P Index (S&P 500, Midcap, Smallcap) in 2005 to analyze I3. The value of the shares the executive owned is calculated by `SHROWN_EXCL_OPTS * PRCCF` (multiplying shares owned and fiscal-year end share price), the value of the newly granted restricted stock is `RSTKGRNT`, value of the newly granted option is `OPTION_AWARDS_BLK_VALUE` (which is valued using S&P’s Black Scholes methodology), the value of the unexercised exercisable option is `OPT_UNEX_EXER_EST_VAL` (value of in-the-money unexercised exercisable options), and the value of the unexercised unexercisable option is `OPT_UNEX_UNEXER_EST_VAL` (value of in-the-money unexercised unexercisable options).\(^{25}\)

As a compensation, I used TDC1 in the Compustat with ExecuComp(1992-2005).

To calculate market capitalization of the firm, I used the same method as Gabaix and Landier (2007) which is the end-of-year share price (data199) * common shares outstanding (data25) + total asset (data6) - total common equity (data60) - deferred taxes in balance sheet (data74).

\(^{25}\)This estimation is based on the similar idea as the "one-year approximation (OA)" in the Core and Guay (2002) in that the OA method uses the characteristics of the newly granted option, previously granted unexercisable and exercisable options.
Table 1: Descriptive Statistics

Notes: This table displays statistics of compensation levels for CEOs, COOs, and CFOs from the firms which are in the major S&P Index (S&P 500, Midcap, Smallcap) in 2005. I used ExecuComp data during 1992 – 2005 and collected TDC 1 for each year which includes salary, bonus, other Annual, total value of restricted stock granted, total value of stock options granted (using Black-Scholes), long-term incentive payouts, and all other totals. All figures are adjusted to 2000 dollars by using the Bureau of Economic Analysis GDP deflator. Units of Mean, Min, and Max are thousands of dollars.

<table>
<thead>
<tr>
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<th>CEO</th>
<th>COO</th>
</tr>
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<tr>
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</tr>
<tr>
<td>1994</td>
<td>491</td>
<td>2478.52</td>
</tr>
<tr>
<td>1995</td>
<td>579</td>
<td>2659.24</td>
</tr>
<tr>
<td>1996</td>
<td>614</td>
<td>3332.44</td>
</tr>
<tr>
<td>1997</td>
<td>720</td>
<td>4432.80</td>
</tr>
<tr>
<td>1998</td>
<td>764</td>
<td>4843.55</td>
</tr>
<tr>
<td>1999</td>
<td>855</td>
<td>5355.16</td>
</tr>
<tr>
<td>2000</td>
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</tr>
<tr>
<td>2001</td>
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<td>6015.31</td>
</tr>
<tr>
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<td>888</td>
<td>4921.78</td>
</tr>
<tr>
<td>2003</td>
<td>1049</td>
<td>4563.2</td>
</tr>
<tr>
<td>2004</td>
<td>1087</td>
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</tr>
<tr>
<td>2005</td>
<td>1116</td>
<td>5264.15</td>
</tr>
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</thead>
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<td>2005</td>
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<tr>
<td>Total</td>
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</table>
Table 2: Regression of Executive Compensation on the Firm Size and the Reference Firm Size

Notes: This table displays the regression result of executive compensation on own firm market capitalization and reference firm market capitalization. Dependant variable is TDC1 of executives at year t during 1992-2005 for firms which are in the major S&P Index (S&P 500, Midcap, Smallcap) in 2005. One of the independent variables (marcap) is own firm market capitalization at year t-1 which is calculated by (data199 * data25 + data6 – data 60 – data74) from the Compustat with ExecuComp data. In panel A, independent variable (marcap75) as the reference firm market capitalization is measured by the upper 75 percentile firm market capitalization at each year t-1. In panel B, independent variable (sp75) as the reference firm market capitalization is measured by the upper 75 percentile firm market capitalization by the historical S&P Major Index Code at each year t-1. All figures are adjusted in 2000 dollars by using the Bureau of Economic Analysis GDP deflator. Standard errors are reported below the coefficient estimates. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.

<table>
<thead>
<tr>
<th>Panel A</th>
<th>Ln(TDC1)</th>
<th>CEO</th>
<th>COO</th>
<th>CFO</th>
</tr>
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<tbody>
<tr>
<td>Ln(marcap)</td>
<td>0.45*** (0.01)</td>
<td>0.32*** (0.01)</td>
<td>0.46*** (0.01)</td>
<td>0.33*** (0.01)</td>
</tr>
<tr>
<td>Ln(marcap75)</td>
<td>0.60*** (0.04)</td>
<td>0.85*** (0.04)</td>
<td>0.32*** (0.08)</td>
<td>0.58*** (0.11)</td>
</tr>
<tr>
<td>Intercept</td>
<td>-0.81* (0.36)</td>
<td>-1.97*** (0.31)</td>
<td>1.20 (0.64)</td>
<td>-0.06 (0.80)</td>
</tr>
<tr>
<td>Firm Fixed Effects</td>
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<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Observation</td>
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<td>9994</td>
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<td>2606</td>
</tr>
<tr>
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<td>0.33</td>
<td>0.36</td>
<td>0.36</td>
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<table>
<thead>
<tr>
<th>Panel B</th>
<th>Ln(TDC1)</th>
<th>CEO</th>
<th>COO</th>
<th>CFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln(marcap)</td>
<td>0.34*** (0.01)</td>
<td>0.33*** (0.01)</td>
<td>0.37*** (0.02)</td>
<td>0.34*** (0.03)</td>
</tr>
<tr>
<td>Ln(sp75)</td>
<td>0.16*** (0.04)</td>
<td>0.68*** (0.04)</td>
<td>0.13*** (0.02)</td>
<td>0.47*** (0.09)</td>
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<tr>
<td>Intercept</td>
<td>3.79*** (0.06)</td>
<td>-0.50* (0.25)</td>
<td>3.53*** (0.11)</td>
<td>0.94 (0.63)</td>
</tr>
<tr>
<td>Firm Fixed Effects</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Observation</td>
<td>9994</td>
<td>9994</td>
<td>2606</td>
<td>2606</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.34</td>
<td>0.32</td>
<td>0.37</td>
<td>0.35</td>
</tr>
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</table>
Table 3: Estimated $\beta$ (Tale Index Parameter) and $\gamma$ (Return-to-Scale Parameter)

Notes: Estimations of the $\beta$ and the $\gamma$ are calculated from the regression results in Table 2. $\beta$ is simply the coefficient of the $\ln(marcap75)$ and the coefficient of the $\ln(sp75)$. $\gamma$ is the summation of the $\ln(marcap)$’s and $\ln(marcap75)$’s coefficient and the summation of the $\ln(marcap)$’s and $\ln(sp75)$’s coefficient.

<table>
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<tr>
<th></th>
<th>CEO</th>
<th>COO</th>
<th>CFO</th>
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</thead>
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<tr>
<td>$\beta$</td>
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<td></td>
</tr>
<tr>
<td>with marcap75</td>
<td>0.60</td>
<td>0.32</td>
<td>0.38</td>
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<td>with sp75</td>
<td>0.16</td>
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<td>0.15</td>
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<tr>
<td>Firm Fixed Effect</td>
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<td>NO</td>
</tr>
<tr>
<td>$\gamma$</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>with marcap75</td>
<td>1.05</td>
<td>0.78</td>
<td>0.82</td>
</tr>
<tr>
<td>with sp75</td>
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<td>0.50</td>
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<tr>
<td>Firm Fixed Effect</td>
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<td>NO</td>
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</table>
Table 4: Summary Statistics of Incentive

Notes: This table shows a summary of the three different incentive measurements of executives during 1992-2005. I1 indicates the dollar increase in the executive wealth in the firm for each dollar increase in his compensation. I2 indicates the dollar increase in the executive wealth in the firm for each 1,000 dollar increase in the shareholder value. I3 indicates the dollar value of the shares which the executive owns. Those three incentive measurements are similar definitions (B₁, BⅡ, and BⅢ in the Edmans, Gabaix, and Landier (2007). I use the Compustat with ExecuComp data. Units of I3 is thousands of dollars adjusted in 2000 dollars by using the Bureau of Economic Analysis GDP deflator.

<table>
<thead>
<tr>
<th>Panel A - CEO</th>
<th>Obs</th>
<th>Mean</th>
<th>Median</th>
<th>Std.Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>10412</td>
<td>88.37</td>
<td>6.91</td>
<td>858.58</td>
<td>1</td>
<td>30686.42</td>
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<tr>
<td>I2</td>
<td>9876</td>
<td>35.18</td>
<td>8.51</td>
<td>78.84</td>
<td>1</td>
<td>938.35</td>
</tr>
<tr>
<td>I3</td>
<td>10403</td>
<td>115835.5</td>
<td>22660.71</td>
<td>499152</td>
<td>381.14</td>
<td>1.05E+07</td>
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</table>

<table>
<thead>
<tr>
<th>Panel B - COO</th>
<th>Obs</th>
<th>Mean</th>
<th>Median</th>
<th>Std.Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
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<td>4.52</td>
<td>34.81</td>
<td>1</td>
<td>443.33</td>
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<tr>
<td>I2</td>
<td>2563</td>
<td>10.66</td>
<td>3.62</td>
<td>27.45</td>
<td>1</td>
<td>391.2</td>
</tr>
<tr>
<td>I3</td>
<td>2755</td>
<td>24117.92</td>
<td>8898.13</td>
<td>48423.9</td>
<td>328.92</td>
<td>479826.7</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel C – CFO</th>
<th>Obs</th>
<th>Mean</th>
<th>Median</th>
<th>Std.Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>4095</td>
<td>7.82</td>
<td>3.88</td>
<td>17.35</td>
<td>1</td>
<td>279.66</td>
</tr>
<tr>
<td>I2</td>
<td>3734</td>
<td>5.46</td>
<td>2.66</td>
<td>12.78</td>
<td>1</td>
<td>255.92</td>
</tr>
<tr>
<td>I3</td>
<td>4095</td>
<td>11069.25</td>
<td>4617.54</td>
<td>26446.18</td>
<td>164.15</td>
<td>454084.6</td>
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</table>
Table 5: Regression of Executive Incentive on the Firm Size

Notes: This table displays the regression results of executive incentive on own firm market capitalization during 1992-2005. Dependent variables (marcap) are the three different incentive measurements (I1, I2, and I3) at year t. Independent variable is own firm market capitalization at year t-1 which is calculated by (data199 * data25 + data6 – data 60 – data74) from the Compustat with ExecuComp data. Marcap and I3 are adjusted in 2000 dollars by using the Bureau of Economic Analysis GDP deflator. Standard errors are reported below the coefficient estimates. *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively.

<table>
<thead>
<tr>
<th></th>
<th>Ln(I1)</th>
<th>Ln(I2)</th>
<th>Ln(I3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A - CEO</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ln(marcap)</td>
<td>0.09*** (0.01)</td>
<td>-0.06*** (0.02)</td>
<td>-0.45*** (0.01)</td>
</tr>
<tr>
<td>intercept</td>
<td>1.56*** (0.09)</td>
<td>2.72*** (0.13)</td>
<td>5.81*** (0.08)</td>
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<td>Firm Fixed Effect</td>
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<tr>
<td>Observation</td>
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<td>9878</td>
<td>9876</td>
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<tr>
<td>R-squared</td>
<td>0.01</td>
<td>0.01</td>
<td>0.15</td>
</tr>
<tr>
<td><strong>Panel B - COO</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ln(marcap)</td>
<td>0.18*** (0.02)</td>
<td>0.05 (0.03)</td>
<td>-0.34*** (0.02)</td>
</tr>
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<td>1.25*** (0.23)</td>
<td>4.09*** (0.13)</td>
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<tr>
<td><strong>Panel C - CFO</strong></td>
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</tr>
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<td>Ln(marcap)</td>
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<td>-0.27*** (0.01)</td>
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<td>3734</td>
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<td>R-squared</td>
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<td>0.11</td>
<td>0.13</td>
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