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Abstract

This paper provides empirical evidence of the effect stock options and total compensation on the job turnover of corporate Chief Executive Officers (CEOs). Our estimates indicate that both the amount and the composition of the compensation package are important determinants of CEO turnover probability. Holding the total amount of compensation constant, an increase in the proportion of stock options in the total compensation from the 25 percentile level to the 75 percentile level would result in a decrease in annual CEO turnover probability from 10 percent to 6.8 percent. The significant negative effect of stock options on CEO turnover is consistent with the view that options are used as deferred compensation to provide longer term incentives to CEOs. Moreover, holding the proportion of stock options constant, if the amount of total compensation increases from the 25 percentile level to the 75 percentile level, the annual turnover probability would decrease from 10 percent to 6.9 percent. Extraordinary amounts of CEO compensation are often justified based on the assumption that they encourage royalty and reduce turnover rate. The negative effect of the total compensation on turnover rate provides some support for such a claim. In addition, we found that a failure to control for the left censoring biases leads to severe underestimation of the effects of firm performance on CEO turnover probability. These biases may have lead previous studies to severely underestimate the dismissal related pay-for-performance sensitivity. The effect of interlocking directorship on CEO turnover probability also disappears after controlling for the biases.

Keywords: CEO Turnover, Unobserved Heterogeneity, Random Effect Model, Deferred Compensation, Pay-for-performance Sensitivity

JEL classification: C33, C35, C41, J33

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1 Introduction

Past empirical studies on CEO compensation have mainly focused on the effect of firm performance on either compensation or on turnover probability. However, few prior studies have investigated the relationship between compensation *and* turnover probability. Since the extraordinary amounts of CEO compensations are often justified based on the assumption that they encourage royalty and reduce turnover-related costs, it is of interest to investigate the actual statistical impact of the amount of compensation on CEO turnover.

When investigating compensation v.s. turnover rate relationship, we also estimate the effect of the *form* of CEO compensation on CEO job turnover. The *form* of compensation is represented by the *proportion* of stock options in the total compensation package. There is a possible negative effect of the stock options on CEO turnover. Stock options can be seen as deferred compensation; Standard option pricing theory implies that option holders would wait to exercise until the strike date in order to maximize their profit. Furthermore, stock options granted to CEOs usually have a vesting period of about three years, and un-vested options are usually forfeited if the CEOs leave their firms. Therefore, a firm can use stock options as deferred compensation to retain executives, and to align their long term incentives with the interest of the firm (Anderson et al, 2000). The possible negative effect of stock options on CEO turnover has been implied by some researchers (i.g., Eaton and Rosen, 1983). However, there has been no empirical investigation of the actual statistical impact.

We seek to make the following contributions. (1) We provide empirical evidence about the link between the amount of CEO compensation and CEO turnover probability. (2) We document the effect of the *form* of compensation on CEO turnover probability. The form of compensation is represented by the proportion of stock options in the total compensation. (3) Upon estimating such relationships, we control for endogeneity by estimating a joint system of equations that incorporates the unobserved heterogeneity variable.

To preview our results, we find that both the amount and the form of total compensation have sizable effects on CEO turnover probability. An increase in the *amount* of total compensation from the 25 percentile level to the 75 percentile level would decrease annual CEO turnover probability from 10 % to 6.9%. This means that, if the turnover probability is constant over time, the expected years the CEO would hold office would increase by as much as 40% (10 years to 14 years). Our results provide some support for the claim that huge compensation package would encourage royalty and reduce turnover rate.

An increase in the *proportion* of options in the total compensation from the 25 percentile level (0.25) to the 75 percentile level (0.66) would decrease the turnover probability from 10.3% to 6.8%. This means that expected years a CEO would hold office would increase by 50%. The estimated negative relationship between the form of compensation and CEO turnover probability provides fresh evidence that stock options are used as deferred compensation to provide incentive for CEOs to remain in the firm longer.

In addition, we found that biases due to left-censoring are potentially severe in CEO compensation data. In our data set, a failure to control for the left censoring biases leads to a gross underestimation of the effect firm performance on CEO turnover probability. After controlling for these biases, our results indicate that a CEO at age 53 would lose 46 cents for every $1000 lost by shareholders. If we failed to control for the biases, a CEO would appear to lose only 15 cents for every $1000 lost by shareholders. This result indicate that the previous studies might have severely underestimated the dismissal related pay-for-performance sensitivity.

Finally, a failure to control for left-censoring biases would lead to a severe underestimation of the effect of total compensation on CEO turnover rate. The effect of interlocking directorship also disappears after controlling for such biases. Thus, our study finds little support for managerial entrenchment hypothesis through interlocking directorship. The presence of interlocking directorship did not appear to have a negative effect on turnover probability for CEOs.

2 Data and sample criteria

Our primary data sources are ExecuComp and Compustat published by Standard and Poors. ExecuComp covers detailed information about the five most highly paid executives in each company within the S&P 500, Midcap 400, and SmallCap 600 firms. We focuse on compensation of CEOs only. The sample covers the years 1993 to 2003. All the compensation figures are deflated by the Consumer Price Index, with year 2003 as the base year. All the data are from ExecuComp and Compustat, except CEO age information which is hand-collected from each corporation's proxy statement; due to the fact that the age variable in ExecuComp, (p_age_2), is extremely incomplete. Our age variable shows the age of CEOs when the proxy statements are filed.

We require that each individual became a CEO in or after 1993, the year our sample period begins, so that there are no left-censored observations in our sample. This is the requirement that distinguishes our sample from most of the prior studies of CEO turnover. To our knowledge, none of the studies about CEO turnover explicitly address the problem associated with left censoring, presumably including CEOs whose tenure started before their sample periods. As is well-known, such inclusion of left censored observations causes biases in the estimates (Heckman and Singer, 1985). We treat each CEO-firm combination as a unique CEO. After eliminating observations that do not match our sample criteria, we obtain an unbalanced panel data set that contain 3031 CEO-years of observation including 1075 corporations and 1450 CEOs.

3 Trend in CEO compensation

We define total compensation as the sum of salary, bonus, and the stock options measured in Black-Sholes values.[1] We ignore other relatively minor components in CEO compensation packages such as short-term incentive plans. Salary, bonus, and stock options constitute the largest part of CEO compensation. They make up nearly 90% of the whole CEO compensation package for all the sample years.

[1]Stock appreciation rights are also included.

The yearly average of total compensation is presented in Table 1. The increase from 1993 to 2000 is rather dramatic. The average total compensation in 1993 is $2 million. This figure tripled to $6 million in year 2000, but declined afterward. 2000 is the year in which the information technology stock "bubble" bursted. The importance of stock options in the total compensation has increased dramatically in the past ten years. Table 1 also shows yearly averages of option mix. Option mix is defined as $\frac{Options}{Total\ Compensation}$. It increases from 0.3 in 1993 to 0.6 in year 2001. Option mix declines after 2001. It is 0.4 in year 2004.

4 Models

Our primary objective is to document the relationship between CEO turnover probability and the *amount* of compensation, and to document the relationship between CEO turnover probability and the *form* of compensation. The form of compensation is represented by option mix. We use two models to estimate such relationships. The first model is a simple panel data logit discrete hazard model. This model does not deal with endogeneity. The second model controls for endogeneity biases by estimating a joint system of equations that incorporates the unobserved explanatory variable.

4.1 Model 1: Panel Data logit discrete hazard model

Our single equation panel data logit discrete hazard model is written as,

$$\begin{aligned} y_{it} &= \beta_0 + \beta_1 log(Total\ compensation)_{it} \\ &+ \beta_2 (Option\ mix)_{it} + Z_{it}^{'}\beta + \mu_{it} \end{aligned} \quad (1)$$

$$such\ that\ if$$

$$\begin{aligned} y_{it} &\geq 0\ then\ CEO\ leaves\ the\ firm\ at\ the\ end\ of\ year\ t \\ y_{it} &< 0\ \ then\ CEO\ stays\ in\ the\ firm\ for\ the\ next\ year. \end{aligned}$$

i indexes each CEO. t indexes the year. Total compensation is defined as the sum of annual salary, bonuses, and stock options. Option mix is computed as $\frac{Options}{Total\ compensation}$. μ_{it} is an error term that is assumed standard logistic. Z_{it} is a vector of variables that directly affects the turnover probability, but not correlated with the error term μ_{it}.

There are some reasons to believe that total compensation and option mix are endogenous variables. Thus, estimating a single logit equation would result in biased estimates. This leads to considering a joint system of equations (Model 2). Model 2 deals with the endogeneity issues by incorporating a time invariant unobserved heterogeneity term in the system.

4.2 Model 2: Unobserved heterogeneity model to deal with endogeneity

Total compensation and option mix may be determined endogenously. For example, total compensation may be influenced by factors such as firm performance. Many researchers also report that option mix is influenced by "investment opportunity sets," such as the market to book asset ratio (Anderson et al, 2000).

Endogeneity problem arises due to the presence of unobserved heterogeneity. Suppose that total compensation is give by $(Total\ Comp)_{it} = \alpha_0 + X'_{it}\alpha + \epsilon_{it}$. If there is an unobserved explanatory variable that affects both y_{it} in equation (1) and $(Total\ Comp)_{it}$, ϵ_{it}

and μ_{it} will be correlated. This means that μ_{it} will also be correlated with $(Total\ Comp)_{it}$, assuming that Z_{it} and X_{it} have some common variables. Thus, under the presence of unobserved heterogeneity, estimating single logit equation leads to biased results.

To deal with the endogeneity problem, we estimate the following system of equations which includes the unobserved heterogeneity term.

$$
\begin{aligned}
Turnover\ equation\ &:\ y_{it} = \beta_0 + \beta_1 log(Total\ compensation)_{it} \\
&\quad +\beta_2(Option\ mix)_{it} + Z_{it}^{'}\beta + (\rho_1\chi_i + \mu_{it}) \qquad (2) \\
Compensation\ equation\ &:\ log(Total\ compensation)_{it} = \alpha_0 + X_{it}^{'}\alpha \\
&\quad +(\rho_2\chi_i + \varepsilon_{it}^{comp}) \qquad (3) \\
Option\ mix\ equation\ &:\ (Option\ mix)_{it} = \gamma_0 + X_{it}^{'}\gamma + (\rho_3\chi_i + \varepsilon_{it}^{mix}) \qquad (4)
\end{aligned}
$$

χ_i is a CEO-firm match specific unobserved explanatory variable that is assumed to be distributed as standard normal. ρ_1, ρ_2 and ρ_3 are the factor loads. We assume that $\epsilon_{it}^{comp} \perp \epsilon_{it}^{mix} \perp \mu_{it}$. Since we do not observe χ_i, this is a part of the error term in each equation. For instance, the error term in the turnover equation is $(\rho_1\chi_i + \mu_{it})$. In other words, the correlation among error terms is captured by χ_i when factor loads are not all equal to zero.

It will be seen in Section 5 that some explanatory variables are constructed using their first-differenced values. Thus, turnover equation is defined only for CEOs whose tenure is no less than two years. This potentially causes selection biases at the initial period. To control for these biases, we incorporate the following selection equation.

$$\begin{aligned} Selection\ equation : I_{it_i} &= \theta_0 + W'_{it_i}\theta + \rho_4\chi_i + \mu^{initial}_{it_i} \qquad (5) \\ such\ that\ if & \\ I_{it_i} &\geq 0\ then\ CEO\ leaves\ the\ firm\ at\ the\ end\ of\ year\ t_i \\ I_{it_i} &< 0\ then\ CEO\ stays\ in\ the\ firm\ in\ the\ next\ period \end{aligned}$$

where t_i is the year in which the individual i becomes a CEO. $\mu^{initial}_{it_i}$ is an error term that is assumed standard logistic. W_{it_i} is a set of exogenous variables that directly affect the initial year turnover. $\rho_4\chi_i$ controls for the possibility of self-selection bias in the second year and later. Therefore, our heterogeneity model is a system of four equations (2), (3), (4) and (5). We assume that $\epsilon^{comp}_{it} \perp \epsilon^{mix}_{it} \perp \mu_{it} \perp \mu^{init}_{it_i}$. The estimation is done by maximum likelihood. The likelihood function can be found in Appendix B.

5 Choice of explanatory variables

Table 2 and Table 3 include the complete lists of our explanatory variables. X_{it} includes Z_{it} variables and excluded variables. Market to book asset ratio, percentage changes in sales, and R&D to asset ratio are the proxy variables for the growth opportunities (Gaver and Gaver, 1993). Anderson et al. (2000) show that such growth opportunity variables affect option mix. Dividend yield is an inverse proxy for growth opportunity (Gaver and Gaver, 1993). $(Perform)_{it}$ is the yearly change in firm values normalized by the previous period firm values, and this is our firm performance variable.

CEO's average exit rate increases significantly at the age of 64 (Table 4). Such an increase is typically considered as due to normal retirement (Goyal and Park, 2001). To control for routine turnover, we include a dummy variable that is 1 if a CEO is aged 64 and over. There is a possible managerial entrenchment effect through interlocking directorship. Hallock (1997) reports that an interlocked CEO earns substantially higher compensation. The dummy variable for interlocking directorship captures the entrenchment effect on CEO turnover. When estimating the total compensation equation, it is important to control for the firm size (Murphy, 1985). The variable, sales, is a typical proxy for the firm size.

Macroeconomic trends also influence CEO compensation. One method to control for macroeconomic trend is to include the GDP figures. However, GDP may have different impacts for different industries. For example, export oriented industry and import oriented industry are affected differently by an increase in GDP. Instead, we use the industry average of total compensation to control for macroeconomic trends. The industry average option mix can also capture macroeconomic trend. For example, the stock market crisis in year 2000 resulted in smaller use of stock options in some industries, especially in IT industry. The industry average option mix is intended to capture such a trend. Table 5 shows the summary statistics of our key variables.

5.1 Exclusion restrictions

Dividend yield is used as an excluded variable. This is because $(Perform)_{it}$ already contains dividend payout information by construction (see Appendix A). Macroeconomic trends have different effects on different industries. If there is a negative macroeconomic shock, the likelihood of a CEO to job-hop to an industry that is less affected by the shock could increase. CEOs' job-hoppings are, however, rare occurrences in our data set. Job-hoppings to a different industry are even rarer.[2] Thus, we exclude macroeconomic trend variables (industry averages of total compensation and option mix) from the turnover equation. In fact, Hasenhuttl and Harrison (2000) report that industry average of total compensation has little effect on the likelihood of a CEO to job-hop. Some of the lagged variables are used as excluded variables. This is due to our assumption that current variables summarize most of the relevant information about current CEO retention decision.

We validate our choice of exclusion restrictions using the method described in Bollen et al (1995). We conduct the test for irrelevance of excluded variables and the test for over-identification restrictions. We have rejected the irrelevance of excluded variable hypothesis, and accepted the over-identification restriction hypothesis both at 5 percent confidence level.[3] Thus, our excluded variables appear to be valid instruments.

6 Estimation results

Table 6 presents the estimated coefficients for selected variables for Model 1, the single turnover equation model, and for Model 2, the heterogeneity model. The coefficient for total compensation is -0.21 for model 1 and -0.29 for model 2. The coefficients for option

[2]Among 1407 individuals in our sample, only 23 individuals job-hopped during our sample periods. Of those, only 4 individuals job-hopped to different industries.

[3]For the irrelevance test, F test statistics with degrees of freedom (10, 1057) are 4.1 for total compensation equation, and 4.6 for option mix equation. For over-identification test, the log likelihood test statistics with 2.44 with df=8.

mix is -0.88 for model 1 and -1.13 for model 2. Both coefficients are larger in magnitude in case of the heterogeneity model, though the the differences between two models do not appear to be substantial.

Note that Model 1 is nested in Model 2 given the restriction that the four factor loads are zero. The χ^2 test of the restriction has strongly rejected such a hypothesis.[4] Thus, we focus on Model 2 as being the most relevant. For Model 2, the coefficients on total compensation, option mix and firm performance are statistically significant at 5 percent confidence level. Notice, however, that the significant effect of heterogeneity only comes from the covariance between total compensation and option mix as can be seen in Table 6. There appears to be no correlation with the error terms in the turnover equation.

6.1 The effects of the amount and the form of compensation on CEO job turnover

The negative and statistically significant coefficient for total compensation is consistent with the claim that a large compensation package encourages royalty. To interpret the magnitude of the estimate, we compute how the annual CEO turnover probability changes when total compensation changes from the 25th percentile level to the 75 percentile level, holding all other variables constant at the median levels. The median levels of selected variables are presented in Table 7.

As can be seen in Table 8, an increase in total compensation from the 25th percentile

[4]The χ^2 test statistic is 1090.45.

level to the 75 percentile level would reduce the annual CEO turnover probability from 10% to 6.9 %. This change may appear to be modest but this is not negligible. Consider the expected years the CEO would hold office. If the separation probability is constant over time, a decrease in the annual turnover probability from 10% to 6.9% means that the expected remaining years would increase from 10 years to 14.5 years. This is more than a 40% increase. Thus, our result gives some support for the claim that a huge CEO compensation package encourages royalty and reduces turnover.

The coefficient for option mix is also negative and statistically significant. This is consistent with the supposition that stock options are used as deferred compensation to bind CEOs to the firm. The magnitude of the coefficient is also significant. As can be seen in Table 8, an increase in option mix from the 25th percentile level to the 75th percentile level would reduce the annual CEO turnover probability from 10.3% to 6.8%. This means that, if the probability of separation is constant over time, the expected years the CEO would hold office increases by as much as 50% if the option mix increases from the 25th percentile level to the 75th percentile level. Significantly negative effect of option mix on the turnover probability provides fresh evidence that stock options are used as deferred compensation to give incentive for CEOs to stay in the firm longer.

6.2 The importance of controlling for the left-censoring biases

We used the sample that excludes left-censored observations in order to control for the left-censoring biases. Much of the prior research about CEO turnover, however, does not control for the left-censoring biases. We found that biases due to left-censoring are potentially severe. Table 9 shows the estimated coefficients for two different samples, one excluding left-censored observations and the other including left-censored observations. We emphasize the following three important findings regarding the left-censoring biases in CEO compensation data.

First, a failure to control for left-censoring biases would lead to a severe underestimation of the effect of total compensation on turnover rate. If we fail to control for left-censoring biases, the coefficients for total compensation reduces by as much as 60% in magnitude (from -.27 to -.11) .

Second, the effect of interlocking directorship disappears after controlling for left censoring biases. This means that the importance of the board being filled with the CEO's supporters may be minimal.

Third, a failure to control for left-censoring biases would lead to a severe underestimation of the effects of firm performance on the CEO turnover rate. The coefficient for $(Perform)_{it}$ will decrease by as much as 50% if we fail to control for such biases. Few previous literature controls for the left-censoring biases. Our results, thus indicate that past literature might have grossly underestimated the true dismissal related pay-for-performance sensitivity. Based on the estimated coefficient for $(Perform)_{it}$ after controlling for left censoring biases, an executive at age 53 would lose 46 cents for every $1000 lost by shareholders if firm performance deteriorates from the 75th percentile level to the 25th percentile. level[5]. If we failed to control for these biases, the executive would

[5]We followed Jensen and Murphy (1990) for the computation of dismissal related pay-for-performance sensitivity. To compute the CEO's expected wealth losses, we assume that an executive would earn the median total compensation (median by age) until the age 65 if he or she is not dismissed. In our data

appear to lose only 15 cents for every \$1000 lost by shareholders. Notice that Jensen and Murphy (1990) estimate that a CEO at age 53 would lose only 8.6 cents for every \$1000 lost by shareholders. This small estimate might have been partly due to a failure to control for left-censoring biases.

7 Conclusion

This paper contributed to the CEO compensation literature by providing a link between the *amount* of CEO compensation and CEO turnover probability, and a link between the *form* of the compensation and turnover probability. The form of compensation is represented by the proportion of stock options as part of CEO compensation. We estimated these relationships using a joint equations model that incorporates a time invariant unobserved explanatory variable.

We found that both the amount and the form of total compensation have significant impacts on CEO turnover probability. An increase in the *amount* of total compensation from the 25th percentile level to the 75 percentile level would decrease the CEO annual turnover probability from 10% to 6.9%. This means that, if the probability of separation were constant over time, the expected years the CEO would hold office would increase by more than 40%. Thus, our result provides support for a common claim that a large pay package encourages royalty of the CEO and reduces turnover rate.

If the *proportion* of stock options in total compensation increase from the 25th

set, the median shareholders would lose \$730 million if the firm performance deteriorate from the 75th to the 25th percentile level.

percentile level to the 75 percentile level, the CEO annual turnover rate would decrease from 10.3% to 6.8%. The negative effect of options on CEO turnover probability is consistent with the view that stock options are used as a deferred compensation that provides longer incentive to CEOs.

Finally, we found that the biases due to left-censoring are potentially severe in the estimation of CEO turnover probability. First, if we fail to control for these biases, the coefficient for total compensation reduces by as much as 60% in magnitude. Second, the effect of interlocking directorship disappears after controlling for these biases. Third, a failure to control for these biases would lead to a severe underestimation of the effects of firm performance on the CEO turnover rate. This may have lead past studies to grossly underestimate the dismissal related pay-for-performance sensitivity.

Table 1: Yearly average of total compensation and Option Mix

Year	# of obs	Average total comp	Average option mix
1993	87	2.05	0.34
1994	79	2.73	0.34
1995	176	2.39	0.32
1996	262	2.52	0.34
1997	323	3.31	0.37
1998	347	3.95	0.42
1999	355	5.54	0.46
2000	376	6.22	0.49
2001	422	5.80	0.55
2002	481	4.98	0.51
2003	480	4.07	0.44

Compensation figures are in million dollars.
Total Compensation = Salary + Bonus + Options.
Options are in Black-Sholes values.
Option Mix = $\frac{Options}{Total\ Compensation}$

Table 2: Choice of explanatory variables and exclusion restrictions

Z_{it} variables (Variables that directly affect turnover)	Excluded variables
$(Perform)_t$	$(Inter\ locking\ directorship\ dummy)_{t-1}$
$log(Market\ to\ book\ asset\ ratio)_{t-1}$	$(\%\ change\ in\ sales)_{t-1}$
$\Delta log(market\ to\ book\ asset\ ratio)_t$	$log(dividend\ yeild + 1)_t$
$(\%\ change\ in\ sales)_t$	$log(dividend\ yeild + 1)_{t-1}$
$(Interlocking\ directirship\ dummy)_t$	$(\frac{R\&D}{assets})_{t-1}$
$(tenure)_t$	$Dummy\{R\&D = 0\}_{t-1}$
$(tenure)_t^2$	$(industry\ average\ option\ mix)_t$
$log(sales)_t$	$(industry\ average\ option\ mix)_{t-1}$
$(\frac{R\&D}{assets})_t$	$(industry\ average\ total\ comp)_t$
$Dummy\{R\&D = 0\}_t$	$(industry\ average\ total\ comp)_{t-1}$
$(CEOage)_t$	
$(CEOage)_t^2$	
$Dummy(CEO\ is\ aged\ 64\ and\ over)_t$	
$Dummy(CEO\ age\ missing)_t$	
$log(stock\ price\ volatility)_t$	
Year dummies	
industry dummies	

For the definitions of variables, see Appendix A

Table 3: Choice of variables for initial turnover equation

Variables
$log(Market\ to\ book\ asset\ ratio)_t$
$\Delta log(market\ to\ book\ asset\ ratio)_t$
$(\%\ change\ in\ sales)_t$
$(Interlocking\ directirship\ dummy)_t$
$log(sales)_t$
$(\frac{R\&D}{assets})_t$
$Dummy\{R\&D = 0\}_t$
$log(stock\ price\ volatility)_t$
$log(dividend\ yeild + 1)_t$
Year dummies
industry dummies
$(industry\ average\ total\ comp)_t$
$(industry\ average\ option\ share)_t$
of years worked at the firm before becoming an CEO
S&P 500 dummy
S&P midcap dummy
$(earnings\ per\ share)_t$
$(number\ of\ board\ meeting\ during\ the\ year)_t$

For the definitions of variables, see Appendix A

Table 4: Average exit rate by CEO age

CEO age	Exit rate	CEO age	Exit rate	CEO age	Exit rate
51 (150)	0.07	57 (195)	0.09	63 (68)	0.13
52 (177)	0.05	58 (180)	0.08	64 (58)	0.38
53 (189)	0.09	59 (160)	0.09	65 (41)	0.34
54 (198)	0.06	60 (136)	0.08	66 (22)	0.36
55 (198)	0.11	61 (123)	0.14	67 (15)	0.33
56 (199)	0.08	62 (88)	0.15	68 (9)	0.22

Inside the brackets are the number of observations. Average exit rate for age=a is computed as $\frac{\#CEOs\ who\ exit\ at\ age\ = a}{\#CEO\ whose\ age = a}$

Table 5: Summary statistics (1993 - 2003)

Variable	# of obs	Mean	St div	Min	Max
Perform	3301	0.35	10.1	-1.0	582.9
log(Market to book asset ratio)	3301	0.55	0.5	-1	3.2
% *sales change*	3301	9.5	32.4	-78.1	783,6346
Interlocking directorship dummy	3301	0.04	0.19	0	1
CEO Tenure	3301	3.7	1.82	1	11
$\frac{R\&D}{Assets}$	3301	0.03	0.07	0	1.19

Table 6: Estimation results by models

	Model 1 (Single equation)	Model 3 (Heterogeneity model)
log(Total compensation)	-0.212	-0.292
	(0.168)	(0.140)
Option mix	-0.878	-1.130
	(0.427)	(0.379)
Perform	-0.342	-0.346
	(0.216)	(0.138)
Interlocking directorship dummy	0.177	0.213
	(0.332)	(0.342)
ρ_1 (turnover equation)	–	0.221
		(0.144)
ρ_2 (Total comp equation)	–	0.536
		(0.012)
ρ_3 (Option mix equation)	–	0.148
		(0.006)
ρ_4 (Selection equation)	–	-0.771
		(0.596)

a. Inside the brackets are standard errors. For model 1, they are robust standard errors.

Table 7: The median, the 25 percentile, and the 75 percentile values for CEOs.

Variables	25th percentile	Median	75th percentile
Total compensation (in million)	1.24	2.40	4.90
Option Mix	.25	.46	.66
Perform	-.17	.07	.34
Log(Market to book asset ratio)	0.19	.45	.83
$\Delta log(Market\ to\ book\ asset\ ratio)$	-.13	0	.12
% change in sales	1.3	6.2	15.2
Interlocking directorship dummy	–	0	1
CEO tenure	1	3	4
Sales (in million)	0.63	1.80	5.29
R & D ratio	0	.002	.03
R & D zero dummy	–	0	1
log(Volatility)	-1.27	-1.00	-.68
CEO age	48	53	58

Table 8: Sensitivity of annual CEO turnover probability due to changes in selected variables

	CEO annual turnover probability		
Variables	25th percentile	50th percentile	75th percentile
Total compensation	0.100	0.083	0.069
Option mix	0.103	0.083	0.068
Perform	0.090	0.083	0.077

Table 9: Sensitivity of estimates to the inclusion of left-censored observations

Variables	Left censoring biases controlled (Sample A)	Left censoring biases NOT controlled (Sample B)
Total compensation	-0.292	-0.111
	(0.140)	(0.068)
Option mix	-1.139	-0.803
	(0.379)	(0.170)
Perform	-0.346	-0.170
	(0.138)	(0.058)
Interlocking directorship	0.213	-0.291
	(0.342)	(0.126)
ρ_1 (turnover equation)	0.221	-0.009
	(0.144)	(0.066)
ρ_2 (Total comp equation)	0.536	0.64
	(0.02)	(0.006)
ρ_3 (Option mix equation)	0.148	0.161
	(0.006)	(0.003)
ρ_4 (Selection equation)	-0.771	–
	(0.596)	–

Sample A excludes left-censored observations. Sample B includes left-censored observations. The estimation results are based on unobserved heterogeneity model.

Appendices

A Variable definitions

$$
\begin{aligned}
(Perform)_t &= \frac{(firm\ value)_t - (firm\ value)_{t-1} + dividend\ payout}{(firm\ value)_{t-1}} \\
(Market\ to\ book\ asset\ ratio)_t &= [Assets - (Total\ common\ equity) \\
&\quad +(Share\ outstanding) \times (Share\ closing\ price)] \\
&\quad \div Asset
\end{aligned}
$$

If CEO i is in industry j and the number of firms in the industry j at time t is N_{jt} then

$$
\begin{aligned}
(Industry\ average\ total\ comp)_{it} &= \frac{1}{N_{jt}-1} \sum_{s\ is\ in\ industry\ j,\ j \neq i} (Total\ compensation)_{st} \\
(Industry\ average\ Option\ mix)_{it} &= \frac{1}{N_{jt}-1} \sum_{s\ is\ in\ industry\ j,\ j \neq i} (Option\ mix)_{st} \\
R\&D\ ratio &= \frac{R\&D}{Assets}
\end{aligned}
$$

B The likelihood function

Since all the error terms, μ_{it}, ε_{it}^{comp}, ε_{it}^{mix} and $\mu_{it_i}^{init}$ are independent conditional on χ_i, individual i's likelihood contribution is written as,

$$
\begin{aligned}
L_i(\Phi|\chi_i) &= \prod_{t\ =\ t_i+1}^{Ti} \{[1 - logit(\widetilde{Z}_{it}'\widetilde{\beta} + \rho_1\chi_i)]^{D_{it}^{exit}} [logit(\widetilde{Z}_{it}'\widetilde{\beta} + \rho_1\chi_i)]^{1-D_{it}^{exit}} \\
&\times \ \phi(log(Total\ compensation)_{it} - \widetilde{Z}_{it}'\widetilde{\alpha} - \rho_2\chi_i, \sigma^{comp}) \\
&\times \ \phi((Option\ mix)_{it} - \widetilde{Z}_{it}'\widetilde{\gamma} - \rho_3\chi_i, \sigma^{mix})\} \\
&\times \ [1 - logit(\widetilde{W}_{it_i}'\widetilde{\theta} + \rho_4\chi_i)]^{D_{it_i}^{init}} [logit(\widetilde{W}_{it_i}'\widetilde{\theta} + \rho_4\chi_i)]^{1-D_{it_i}^{init}} \qquad (6)
\end{aligned}
$$

$$where$$

$$\begin{aligned} logit(v) &= \frac{e^v}{1+e^v} \\ \phi(v,\sigma) &= \frac{1}{\sqrt{2\pi}\sigma} exp(-\frac{v^2}{2\sigma^2}) \end{aligned}$$

The term, $\widetilde{Z'_{it}}\widetilde{\beta}$, represents the observable part of equation (2). Other terms with a tilde have the same meaning. Φ is the union of all the coefficients to be estimated. To obtain the unconditional likelihood, we integrate out χ_i. Unconditional likelihood contribution of individual i is give by,

$$L_i(\Phi) = \int_{-\infty}^{\infty} L_i(\Phi|v) \frac{1}{\sqrt{2\pi}} exp(-\frac{v^2}{2}) dv \tag{7}$$

Unfortunately, we do not have a closed form for this. We approximate $L_i(\Phi)$ using the Gauss-Hermite approximation with 5 mass points.

$$L_i(\Phi) \approx \widetilde{L_i}(\Phi) = \sum_{k=1}^{5} w_k L_i(\Phi|v_k) \tag{8}$$

where the weights w_k and the support point v_k are chosen using 5 points Gauss-Hermite formula.

Let N be the number of individuals in the sample. We maximize the following likelihood function over Φ to obtain the estimated coefficients.

$$L(\Phi) = \prod_{i=1}^{N} \widetilde{L_i}(\Phi) \tag{9}$$

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