Gender and Dynamic Agency: Theory and Evidence on the Compensation of Top Executives

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Gender and Dynamic Agency: Theory and Evidence on the Compensation of Top Executives*†

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Abstract

We document three new facts about gender differences in executive compensation. First, female executives receive *lower share of incentive pay* in total compensation relative to males. This difference accounts for 93% of the gender gap in total pay. Second, the compensation of female executives displays *lower pay-performance sensitivity.* A $1 million dollar increase in firm value generates a $17,150 increase in firm specific wealth for male executives and a $1,670 increase for females. Third, female executives are *more exposed to bad firm performance* and less exposed to good firm performance relative to male executives. We find no link between firm performance and the gender of top executives. We discuss evidence on differences in preferences and the cost of managerial effort by gender and examine the resulting predictions for the structure of compensation. We consider two paradigms for the pay-setting process, the efficient contracting model and the "managerial power" or skimming view. The efficient contracting model can explain the first two facts. Only the skimming view is consistent with the third fact. This suggests that the gender differentials in executive compensation may be inefficient.

JEL Classification: G3; J16; J31; J33; M12.
Keywords: Gender differences in executive pay; incentive pay; pay-performance sensitivity.

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1 Introduction

We document three new facts about gender differences in the structure of executive compensation. First, female executives receive a *lower share of incentive pay* in total compensation relative to males. This difference accounts for 93% of the gender differences in total flow compensation. Second, the compensation of female executives displays a *lower pay-performance sensitivity* relative to males. A $1 million dollar increase in firm value generates a $17,150 increase in firm specific wealth for male executives and a $1,670 increase for females. Third, female executives' pay is *more exposed to bad firm performance* and less exposed to good firm performance than for males. A 1% increase in firm value generates a 13% rise in firm specific wealth for female executives, and a 44% rise for male executives, while a 1% decline in firm value generates a 63% decline in firm specific wealth for female executives and only a 33% decline for male executives. We also show that there is no link between firm performance and the gender of top executives. These results are based on ExecuComp, Standard&Poor's database on executive compensation, and control for the fact that women are younger and tend to hold lower ranked titles.

What drives these differences in the structure of compensation by gender? To examine this question, we discuss evidence on gender differences in preferences and the cost of managerial effort and examine the resulting predictions for the structure of compensation based on two models of the firm-executive relationship.

Our analysis builds on an extensive literature on gender differences in attributes relevant for the executive labor market. First, surveys of professionals and managers point to the existence of a pervasive set of barriers to career advancement for women. These include exclusion from informal networks, gender based stereotyping, lack of mentors and role models and asymmetric allocation of household responsibilities (Catalyst, 2004a). The evidence of gender asymmetries in the personal cost of career investments in relation to marriage and parenthood is also substantial. High earning professional and executive women are less likely than men in similar circumstances to be married or have children, but they bear a larger fraction of household responsibilities if married (Hewlett, 2002). Finally, there is substantial evidence of gender differences in preferences from field and experimental studies. We concentrate on three attributes that appear particularly relevant for executives: ability to perform in competitive environments, propensity to compete and initiate negotiations, and risk aversion, all of which seem to be substantially lower for women.[1]

To explore the impact of these gender differences on executive compensation, we consider two paradigms, the classic agency model of executive compensation and the "managerial power" or skimming view. According to the agency model (Holmstrom, 1979, and Jensen and Murphy, 1990), shareholders set executive's pay to maximize the surplus from their relationship. Private information over the executive's effort generates moral hazard, which requires pay to be sensitive to firm performance to insure incentive compatibility. Equity based pay or explicit bonus programs can be used to obtain this effect. Under this paradigm, the structure, as well as the level, of executive compensation will reflect actual or perceived attributes of the executive, such as their impact on firm performance, their cost of effort and risk aversion.

The managerial power or skimming view (Bertrand and Mullainathan, 2001, and Bebchuk and Fried, 2003) is based on the notion that the members of the board of directors, who are typically responsible for setting executive pay, cannot be expected to make decisions to maximize shareholder value. The incentive to be re-elected, informal networks linking them to CEOs, cognitive dissonance, and ratcheting all imply that executives can exert significant power over their own compensation. This has implications for the structure, as well as the level of pay. Executive compensation will rely more on forms of pay that are less transparent, and will be more sensitive to good firm performance than to adverse performance. These patterns should be more prevalent for executives that are more entrenched.

[1] We review this evidence in more detail and discuss its limitations in Section 3

If we posit that gender differences in performance in competitive environments, propensity to compete and to initiate negotiation and weight of household responsibilities reduce the impact of female executive on firm performance and increase their cost of effort, the efficient contracting model can explain the fact that female executives have a lower share of incentive pay in total compensation and display lower pay-performance sensitivity. These patterns are also consistent with the evidence on risk aversion by gender. However, the efficient contracting model cannot explain why female executives are more exposed to adverse firm performance. The skimming view is consistent with this fact, since female executives, who are younger, have lower tenure and are limited in accessing informal networks, are likely to be less entrenched than their male counterparts.

Our results suggest that the gender differences in the structure and level of compensation are not efficient. The gender differentials in the level of compensation are mostly accounted for by those in the share of incentive pay. Moreover, female executives' greater exposure to risk can be linked to equity based compensation. The implications of these findings extend beyond the executive labor market. Lemieux, MacLeod and Parent (2009) document a rise in the fraction of U.S. jobs explicitly linking pay to performance since the late 1970s. They show that this trend can explain a sizable fraction of the growth in male wage dispersion, especially at the top-end. Hall and Murphy (2003) discuss the rise in equity based programs for employees at all levels since the early 1990s. Albanesi and Olivetti (2009) find that gender earnings differentials are greatest in occupations and industries with higher incidence of incentive pay.

The failure of the efficient contracting paradigm to explain the three facts on gender differences in the structure of executive compensation points to the possibility of distortions in the link between pay and performance that may influence a broader set of workers as incentive pay schemes become increasingly important. To the extent that performance pay amplifies earnings differentials resulting from effective or perceived differences in attributes across workers, if designed incorrectly, it exacerbates inequality and discrimination and can severely distort the allocation of resources. Our analysis suggest that performance pay schemes should be held to closer scrutiny and raises a note of concern for the standing of professional women in the labor market as incentive pay becomes more prevalent.

The paper is organized as follows. We discuss the three facts on gender differentials in the structure of compensation in Section 2. Section 3 reviews the evidence on gender differences in preferences and barriers to career advancement. We describe the efficient contracting model of executive compensation and the skimming view in Section 4 and evaluate their predictions against the evidence on gender differences in preferences and the structure of executive compensation. Section 5 discusses some open questions.

2 Evidence on the Compensation of Top Executives

It is well known that there are significant gender differences in the *level* of compensation for top executives. Bertrand and Hallock (2001) are the first to systematically document this gender differentials based on ExecuComp data. They show that the gender differential can, for the most part, be accounted for by the size and industry distribution of female executives, in particular, the fact that women are represented in smaller firms and that they are less likely to hold the title of CEO (or other top ranked titles). The fact that female top executives are younger and have fewer years of tenure contributes to explain most of the remaining gender differential in total compensation. Additional studies by Bell (2005), and Elkinaway and Stater (2011) further confirm these results. By contrast Gayle, Golan and Miller (2012) find that controlling for executive rank and background, women earn higher compensation than men and are promoted more quickly, but experience more income uncertainty. They also find that the unconditional gender pay gap and job-rank differences are primarily attributable to female executives exiting the occupation at higher rates than men.

The contribution of our paper is to use ExecuComp data for 1992 to 2005 to document three new facts about gender differences in the *structure* of executive compensation.

Fact 1: Female executives receive *lower levels of incentive pay* relative to males. For the yearly flow of compensation, we find a residual female-male gap of -6 log points. The gap is much larger for measures of firm specific wealth, ranging from -10 to -30 log points.

Fact 2: The compensation of female executives displays a *lower pay-performance sensitivity* relative to males. A $1 million increase in firm value generates a $17,150 increase in firm specific wealth for male executives and a $1,670 increase for females.

Fact 3: The compensation of female executives is *more exposed to declines in firm value* and less exposed to increases in firm value than that of males. While a 1% rise in firm value is associated with a 13% and 44% rise in firm specific wealth for female and male executives, respectively, a 1% decline in firm value is associated with a 63% decline in firm specific wealth for female executives and a 33% decline for males.

Finally, we show that there is no link between standard measures of firm performance and female representation in the team of top executives. It is, therefore, unlikely that we are only capturing differences in performance by female-led firms.

2.1 Data and sample selection

Our analysis is based on data from Standard & Poor's ExecuComp. This data set collects information on the compensation of top executives in firms belonging to the S&P 500, the S&P Midcap 400 and the S&P SmallCap 600. Firms report compensation data for the top 1 to 15 executives, depending on size. Approximately 70% of firms report information for 4 to 9 top executives, around 45% of the firms in the sample report information for 5 to 6 executives. To minimize potential problems due to the variation in the number of executives across firms we focus on the top-5 executives as defined by title. Specifically, our sample only includes Chair/CEOs, Vice Chairs, Presidents, CFOs and COOs.

Although the ExecuComp data set runs from 1992 to the present, we restrict our sample to the period 1992-2005. This is because of the disclosure reform passed in 2006 which changed reporting of several form of incentive pay thus making pre and post 2006 data not directly comparable.[2] The resulting sample with non-missing information on the relevant variables includes 40,704 executives of which 1,312 are females (that is, women are only 3.2% of our sample). Table 10 in the Data Appendix presents summary statistics on the composition of this sample. Female executives are on average younger than male executives (48 and 54 years of age, respectively) and have lower average firm tenure (8 and 14 years, respectively). Women tend to be under-represented at higher ranks. The percentage of female CEOs is 1.4% over the entire period (growing from a mere 0.002% in 1992 to 2.2% in 2005). Women make 6% of all CFOs, 4.3% of all Vice Chairs, 4.5% of all Presidents and 3.5% of all COOs.

The information on age and tenure is only available for a sub-sample of executives. Controlling for age reduces the sample by 28% and, unfortunately, we loose a disproportionate amount of female executives. The share of female in this case drops to 2.3% of sample.[3]

[2]The change in reporting rules in 2006 resulted in a change in the definition and availability of ExecuComp variables. So for the post-2006 period most items under the 2006 definition are not fully comparable to those under the 1992 definition, which we use in our analysis. See Data Appendix for further details on sample selection.

[3]When controlling for non-missing age, the male executives sample declines by 27% while the female executive sample declines by half, see table 10 in the Data Appendix. The loss is even more severe for tenure, in this case we loose 62% of all the observations. Thus, we do not use this control in our analysis.

2.2 Main Variables

Most of our analysis focuses on three alternative ways to measure total executive compensation.

The first and most commonly used measure is TDC1. This is a flow measure that includes salary as well as an array of "incentive pay" components that are perceived to be linked to firm performance. In ExecuComp, these correspond to Bonus, Stocks Granted and Stock Options. Bonus typically includes discretionary bonus as well as cash payments resulting from performance based bonus programs. Stocks Granted and Stock Options are a measure of the equity component of incentive pay.[4]

One important feature of incentive pay is that it leads to the build up of firm specific wealth, from previous years' flow of stock options and stock grants. Small fluctuations in a company's stock value may lead to large swings in the value of outstanding stock options and stock grants, typically larger than flow components of compensation. For this reason, we consider two additional measures of compensation that capture the executive's stock of firms specific wealth. Specifically, we use the total value of an executive's accumulated stock options (SO Total) and stock grants (SG Total) to measure pay for performance. These two measures are typically analyzed in the corporate finance literature but not in relation to the study of gender differentials.[5]

2.3 Gender Differences in Incentive Pay

We start by exploring gender differences in average and median compensation for all components of executive pay and at different levels of aggregation. Table 1 reports the statistics for the flow pay components (column 1 to 6) as well as for our two measures of an executive's stock of wealth (column 7 and 8). As shown in column 1, the female/male ratio for TDC1, which includes salary, bonus and all the additional components of incentive pay, is 82% for the mean and 86% for the median. The biggest gender differences among the sub-components of TDC1 are observed for Bonus, for which the female/male ratio is 71% for the mean and 83% for the median, and Other pay, for which the ratio is 68% for the mean and 60% for the median. As shown in column 7 and 8, the gender differential in the value of stock options (SO Total) is also large and significant but the largest gender differential is observed for the market value of stock grants held (SG Total). In this case the female/male ratio is 22% for the mean and 30% for the median.

The gender differences in flow incentive pay explain a sizable fraction of the gender difference in total flow compensation. Specifically, the fraction of gender differences in yearly total compensation explained by differences in the flow of incentive pay, that is

$$\frac{\text{Incentive Pay}_m - \text{ Incentive Pay}_f}{TC_m - TC_f},$$

is 93%. Gender differences in stock options grants alone account for 41% of the gender difference in flow compensation. However, stock grants play a much larger role for gender differences in firm specific wealth, as they account for 99.7% of the gender difference in firm specific wealth.

Next we study whether the documented gender differentials in TDC1, SO Total and SG Total can be explained by gender differences in observable characteristics. To this end, we estimate regression 1, where the dependent variable is the logarithm of a specific component of pay. In the baseline specification, the independent variables include a female dummy with time and firm fixed effects.[6] We then progressively

[4] Bebchuk and Fried (2003) have argued that stock options programs are often structured in a way that does not make them sensitive to performance. We explore this issue in Section 2.4.

[5] See Data Appendix for detailed variable definitions.

[6] We also considered a specification that controls for firm characteristics, such as size and performance, as well

Table 1: Gender Differences in Average and Median Pay

Compensation	(1) TDC1	(2) Salary	(3) Bonus	(4) Stock Options	(5) Stock Grants	(6) Other	(7) SO Total	(8) SG Total
Mean females	2542	382	367	1186	287	201	457	13572
Mean males	3099	452	518	1412	332	297	610	60796
F/M mean	0.82	0.85	0.71	0.84	0.87	0.68	0.75	0.22
p-value	0.02	0.00	0.00	0.19	0.65	0.01	0.00	0.07
Median females	1199	322	190	288	0	19	187	686
Median males	1389	376	229	313	0	32	215	2312
F/M median	0.86	0.86	0.83	0.92		0.60	0.87	0.30
p-value	0.00	0.00	0.00	0.32		0.00	0.01	0.00
Observations	40,704	45,548	45,548	40,704	45,548	45,548	40,222	37,581

Notes: $TDC1$ is salary and bonus plus stock options granted, plus restricted stock granted, plus other payments (including long-term incentive plans), *StockOptions* is stock options granted, valued using Black and Scholes methodology, *StockGrants* is the value of restricted stock granted, $SOTotal$ is the estimated value of unexercised plus unexercisable options, $SGTotal$ is the value of shares owned - options excluded. Means and medians are reported in thousands of dollars. Ratios are reported as fractions. Data Source: Standard & Poor's ExecuComp. Sample period: 1992-2005.

include a set of executive characteristics as conditioning factors. Specifically, we estimate the following regression:

$$y_{ijt} = \alpha_0 + \alpha_1 F_i + \alpha_2 X_{ijt} + T_t + f_j + \varepsilon_{ijt}, \quad (1)$$

where y_{ijt} is the logarithm of incentive pay for executive i, in firm j at year t in constant US dollars, F_i is the female dummy, X_{ijt} is the vector of executive characteristics, T_t are the year dummies and f_j corresponds to the firm fixed effects.[7] The results are reported in Tables 2 to 4.

The first variable we consider is the flow measure of total compensation, TDC1, in Table 2. As previously noted, most of the gender differences in the dollar value of TDC1 are accounted for by the incentive pay component. Being a flow variable, this is the most conservative measure of incentive pay. Based on the estimates of the female dummy coefficient, TDC1 is 20 log points lower for women in the baseline specification (column 1), which only includes time effects. Including firm fixed effects (column 2), actually increases the coefficient on the female dummy by 11 log points, indicating that the gender gap in TDC1 is not driven by differences in sorting by firm productivity. Both estimates are significant at the 1% level. Column (3) controls for title. We include a dummy for Chair/CEO, COO, President, and Vice President (the omitted category is CFO). In this case, the estimated female-male difference in TDC1 is -9 log points and significant at the 1% level. The gender gap drops to -6 log points when we include interactions between title and female dummy (column 4). This indicates that the log TDC1 of a female CFO is 6 log points lower than that of a male CFO, statistically significant at the 5% level. Looking at the overall marginal effects (not reported in the table) the strongest gap in TDC1 is observed for females

as for industry fixed effects. This specification delivers similar results with lower explanatory power relative to our benchmark specification with firm fixed effects.

[7]For all regressions, we report robust standard errors, clustered at the firm-year level.

in Vice Chair positions, 23 log points, followed by COOs, 19 log points, and Presidents, 12 log points.

Table 2: Gender Differences in Incentive Pay. TDC1

	Dependent variable is: log TDC1							
	Full sample, (1)-(5)					Age sample, (6)-(8)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
F	-0.207***	-0.310***	-0.0931***	-0.0630**	-0.125***	-0.126***	-0.0140	-0.0427
	(-6.699)	(-13.47)	(-4.566)	(-2.11)	(-5.884)	(-3.698)	(-0.460)	(-1.361)
$Chair/CEO$			0.823***	0.824***	0.819***		0.739***	0.737***
			(99.12)	(97.35)	(98.22)		(56.06)	(55.63)
$ViceChair$			0.290***	0.297***	0.288***		0.201***	0.199***
			(16.87)	(16.86)	(16.77)		(9.707)	(9.659)
$President$			0.282***	0.285***	0.281***		0.333***	0.332***
			(29.19)	(28.54)	(29.03)		(24.34)	(24.22)
COO			0.279***	0.285***	0.278***		0.263***	0.262***
			(15.82)	(15.69)	(15.77)		(11.21)	(11.18)
$F \times Chair/CEO$				0.0406				
				(0.573)				
$F \times ViceChair$				-0.172***				
				(-2.817)				
$F \times President$				-0.0561				
				(-1.196)				
$F \times COO$				-0.131				
				(-1.599)				
F^{CEO}					-0.122*			-0.0477
					(-1.950)			(-0.651)
$F \times F^{CEO}$					0.201***			0.116
					(3.257)			(1.459)
Age						0.0916***	0.0752***	0.0749***
						(16.63)	(14.03)	(14.00)
Age^2						-0.00072***	-0.00068***	-0.00068***
						(-14.74)	(-14.46)	(-14.42)
Constant	6.904***	6.698***	6.146***	6.144***	6.150***	3.956***	4.158***	4.167***
	(183.8)	(291.7)	(264.0)	(263.5)	(263.9)	(25.42)	(27.51)	(27.62)
Observations	40,700	40,700	40,700	40,700	40,700	30,136	30,136	30,136
R-squared	0.027	0.524	0.608	0.608	0.608	0.583	0.627	0.627
Firm FE		X	X	X	X	X	X	X

Notes: See Table 1 for variable definitions and data sources. All specifications include year effects. In column (3) to (5), (7) and (8) the omitted title category is CFO. Standard errors are clustered at the firm-year level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Column (5) controls for title, the presence of a female Chair/CEO and its interaction with the female dummy. In this case we find a -12.5 log points female differential, on average across all titles, for firms headed by a male CEO. The coefficient on the female CEO dummy is negative and significant at the 10% level, suggesting that in firms with a female CEO, TDC1 is about 12 log points lower. However, the coefficient on the interaction between the female dummy and the dummy for a female Chair/CEO is +20 log points, and significant at the 1% level. This suggests that the gender gap in TDC1 is much smaller in firms that are headed by a female CEO, consistent with Bell (2005). This finding could in part be driven by composition, as the CEO/Chair is typically the highest paid executive.

Columns (6)-(8) correspond to the group of observations for which age is available, which substantially reduces the sample size. Comparing column (2) to column (6) we can see that controlling for age and its square, reduces the coefficient on the female dummy by 60%. The gender gap in TDC1 is now about 13 log point. Adding controls for title (column 7) drives the gender gap to 1.4 log points and the coefficient is not statistically significant. There are disproportionately fewer female executives in the sample with non-missing age (their share drops from 3.2% to 2.3%), thus this can at least in part explain the loss of precision in the estimate.

We now turn to stock measures of incentive pay. The results are reported in Table 3, for SG Total, and Table 4, for SO Total. We report the same specifications as for TDC1. For both measures of the stock of firm specific wealth owned by executives, the estimated gender differences in pay are much larger, both in size and significance, than for TDC1. For SG Total, the estimated coefficient on the female dummy ranges from a maximum of approximately -110 log points in column (1) and (2), to a minimum -26 log points in column (7) where we control for title as well as age and its square. For SO Total, the female/male differential ranges from a maximum of -54 log points in column (2) to a minimum of -10 log points in column (7) where we control for title, age and its square. For both variables, the gender gap is statistically significant across all specifications.

As for TDC1, a female Chair/CEO matters. For SG Total, male executives in female headed firms have lower pay than in male headed firms (-42 log points in column 5), controlling for title. The coefficient on the interaction term between the female dummy and the female Chair/CEO dummy is positive but not significant, suggesting that most of the effect is driven by the fact that the CEO is a woman, which increases average pay of women executives at these firms. The same pattern holds conditioning on age.

Looking at SO Total in Table 4, female headed firms have a negative effect on male executive pay, -15 log points (see column 5), as well as on the gender gap in pay. Specifically, the gender gap for firms that do not have a female CEO is -27 log points, while it is +8 log points in firms that do.

Taken together, these results suggest that most of the gender differences in pay stem from incentive pay components, especially the value of outstanding firm specific wealth of the executive, held in the form of stock options and stock grants. We now proceed to explore the implications for pay performance sensitivity.

Table 3: Gender Differences in Incentive Pay. SG Total

	Dependent variable is: log SG Total							
	Full sample, (1)-(5)					Age sample, (6)-(8)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
F	-1.085***	-1.096***	-0.436***	-0.315***	-0.443***	-0.540***	-0.256***	-0.310***
	(-15.73)	(-16.35)	(-7.329)	(-3.706)	(-6.905)	(-5.438)	(-2.820)	(-3.116)
$Chair/CEO$			2.259***	2.269***	2.258***		1.893***	1.888***
			(92.13)	(90.77)	(91.48)		(50.35)	(50.05)
$ViceChair$			1.142***	1.143***	1.139***		0.845***	0.840***
			(25.67)	(25.49)	(25.55)		(15.85)	(15.73)
$President$			0.409***	0.420***	0.407***		0.577***	0.572***
			(14.53)	(14.56)	(14.44)		(14.49)	(14.35)
COO			0.212***	0.222***	0.211***		0.184***	0.182***
			(4.205)	(4.284)	(4.184)		(2.664)	(2.628)
$F \times Chair/CEO$				-0.295				
				(-1.593)				
$F \times ViceChair$				0.0908				
				(0.420)				
$F \times President$				-0.217				
				(1.640)				
$F \times COO$				-0.229				
				(-0.947)				
F^{CEO}					-0.420***			-0.445***
					(-3.660)			(-2.940)
$F \times F^{CEO}$					0.150			0.345
					(0.904)			(1.557)
Age						0.0311*	-0.0161	-0.0169
						(1.733)	(-0.964)	(-1.012)
Age^2						0.0006***	0.0007***	0.0007***
						(3.741)	(4.630)	(4.674)
Constant	7.822***	7.609***	6.105***	6.098***	6.112***	4.519***	5.326***	5.356***
	(100.6)	(140.9)	(105.6)	(105.2)	(105.7)	(9.109)	(11.60)	(11.65)
Firm FE		X	X	X	X	X	X	X
Observations	35,995	35,995	35,995	35,995	35,995	27,188	27,188	27,188
R-squared	0.010	0.360	0.523	0.523	0.524	0.506	0.581	0.581

Notes: See Table 1 for variable definitions and data sources. All specifications include year effects. In column (3) to (5), (7) and (8) the omitted title category is CFO. Standard errors are clustered at the firm-year level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Gender Differences in Incentive Pay. SO Total

	Dependent variable is: log SO Total							
	Full sample, (1)-(5)					Age sample, (6)-(8)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
F	-0.350***	-0.538***	-0.209***	-0.129***	-0.265***	-0.267***	-0.0944**	-0.178***
	(-8.102)	(-18.01)	(-8.138)	(-3.583)	(-9.797)	(-6.305)	(-2.537)	(-4.440)
$Chair/CEO$			1.190***	1.192***	1.183***		1.005***	0.998***
			(115.4)	(112.8)	(113.7)		(63.45)	(62.42)
$ViceChair$			0.498***	0.504***	0.494***		0.316***	0.312***
			(23.25)	(23.02)	(23.10)		(12.49)	(12.34)
$President$			0.325***	0.336***	0.322***		0.363***	0.359***
			(25.48)	(25.57)	(25.27)		(20.31)	(20.08)
COO			0.315***	0.324***	0.314***		0.294***	0.291***
			(14.68)	(14.71)	(14.62)		(10.63)	(10.53)
$F \times Chair/CEO$				0.0987				
				(1.154)				
$F \times ViceChair$				-0.119				
				(-1.568)				
$F \times President$				-0.238***				
				(-4.092)				
$F \times COO$				-0.186*				
				(-1.737)				
F^{CEO}					-0.152**			-0.0971
					(-2.269)			(-1.255)
$F \times F^{CEO}$					0.350***			0.339***
					(4.702)			(3.844)
Age						0.105***	0.0855***	0.0846***
						(13.01)	(11.61)	(11.48)
Age squared						-0.00072***	-0.00071***	-0.0007***
						(-9.752)	(-10.61)	(-10.48)
Constant	4.666***	4.491***	3.717***	3.713***	3.723***	1.090***	1.356***	1.386***
	(85.37)	(121.9)	(99.28)	(99.12)	(99.37)	(4.932)	(6.743)	(6.882)
Firm FE		X	X	X	X	X	X	X
Observations	36,706	36,706	36,706	36,706	36,706	27,171	27,171	27,171
R-squared	0.057	0.562	0.684	0.684	0.684	0.655	0.714	0.715

Notes: See Table 1 for variable definitions and data sources. All specifications include year effects. In column (3) to (5), (7) and (8) the omitted title category is CFO. Standard errors are clustered at the firm-year level. Robust t-statistics in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

2.4 Gender Differences in Pay-Performance Sensitivities

We now turn to Facts 2 and 3. To explore pay-performance sensitivities by gender, our baseline approach is to regress the change in compensation or firm specific wealth on the change in firm value, a female dummy, as well as its interaction with the change in firm value, controlling for firm and time effects, and an industry market performance measure. We also control for executive characteristics, such as age and title, and for firm size, as proxied by the log value of assets. The baseline specification is:

$$\Delta y_{ijt} = \beta_0 + \beta_1 F_i + \beta_2 \Delta V_{ijt} + \beta_3 \Delta V_{ijt} \times F_i + \beta_4 \Delta V_{ijt}^{ind_j} + \beta_5 X_{ijt} + T_t + f_j + \varepsilon_{ijt}, \quad (2)$$

where V_{ijt} is firm value for executive i, in firm j at year t and V^{ind_j} is an index of industry value for firm j, constructed as the average change in firm value in the industry, weighted by firm value, excluding firm j.

The estimates for the baseline specification are presented in Table 5. As in Section 2.4, we use TDC1 as a measure of executive flow compensation, and SG Total and SO Total as measures of firm specific wealth. We only present estimates for SG Total, as we do not find any significant relation between firm performance and the change in TDC1 or SO Total. Column (1) reports the estimates for the baseline specification, which includes firm and time effects, whereas column (2) also controls for title and age. In both cases, the coefficient on the change in firm value is positive and highly significant, whereas the coefficient on the interaction between the change in firm value and the female dummy is negative and highly significant. These estimates suggest that, for each \$1mil increase in the firm's market value, SG Total rises by \$17,150 for men and by only \$1,670 for women (column 1).[8] We also explore the sensitivity of executive pay to fluctuations in the value of the aggregate market, calculated as the weighted average of the change in market value for all the firms in the sample. This control is intended to capture the relation between executive pay and forces outside the executive's control that affect the economy as a whole. We find no significant relation for male or female executives.

Columns (3) and (4) repeat the analysis using the percentage change in firm value. A 1% rise in market value increases SG Total by \$60 thousand for male executives, while it increases it only by \$10 thousand for female executives (column 3). Once again there is no relation between the change in male executives' firm specific wealth and the change in aggregate market value, though for female executives it declines corresponding to a rise in aggregate market value. The corresponding estimated coefficient is significant at the 10% level. The difference between female and male pay-performance sensitivity is not significant conditioning on age and title (column 4).[9]

To assess whether male and female executives have different exposure to good and bad firm performance, we estimate a version of equation 2 that distinguishes between positive and negative changes in market value. For this specification, the variable ΔV_+ captures the changes in firm market value that are greater than zero, while the variable ΔV_- captures the changes in firm market value that are smaller than zero, keeping the negative sign.[10] The results are displayed in Table 6.

Once again, the gender disparities in pay performance sensitivities are large and significant. Based on the estimates in column (2), which condition on title and age, we find that while for men SG Total rises by \$22,850 when the firm's market value rises by \$1mil, for women it only rises by \$16,030. Similarly, every \$1mil decline in their firm's market value is associated with a \$15,720 decline in SG Total for male executives, and with a \$3,060 *rise* for female executives. Using the percentage specification (columns 3-4)

[8] Controlling for title results in estimates similar to those in column (1). Hence the main difference between estimates in columns (1) and (2) arises from the age sample and the age controls.

[9] When controlling for titles only on the full sample, the estimated coefficients and significance levels do not change with respect to those in column (3).

[10] There are no observations in our sample where the change in firm value between two years is exactly zero.

TABLE 5: Pay Performance Sensitivity. SG Total

	Dependent variable is: $\Delta SGTotal$			
	(1)	(2)	(3)	(4)
F	1,320	627.0	6,792	8,390
	(0.198)	(0.0458)	(1.189)	(0.930)
ΔV	17.15***	20.08***		
	(3.663)	(3.588)		
$F \times \Delta V$	-15.48***	-16.58***		
	(-3.314)	(-2.819)		
ΔV_{agg}	-0.212	-0.108	0.227	0.361
	(-0.235)	(-0.0916)	(0.272)	(0.326)
$F \times \Delta V_{agg}$	0.318	0.228	-0.464	-0.591
	(1.014)	(0.503)	(-1.526)	(-1.129)
$\%\Delta V$			59,833***	71,941***
			(3.015)	(3.008)
$F \times \%\Delta V$			-49,828***	-87,133*
			(-2.460)	(-1.678)
Title		X		X
Age		X		X
Constant	185,344**	375,152**	116,854	284,419
	(2.288)	(2.107)	(1.122)	(1.434)
Observations	28,257	22,266	28,257	22,266
R^2	0.104	0.124	0.020	0.026

Notes: See Table 1 for variable definitions and data sources. All specifications control for firm and year effects, log real assets, and change in industry value. Standard errors are clustered at the firm-year level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

delivers similar results. For every 1% increase in the firm's market value, SG Total rises by $66,141 for men, while it *declines* by $32,912 for female executives. For every 1% decline in the firm's market value, SG Total declines by $115,482 dollars for men and by $62,297 for female executives (column 6).[11,12]

These results suggest that female executives' firm specific wealth fluctuates less in response to changes in firm performance, consistent with their lower share of incentive pay. The estimates also show considerable asymmetry in the responsiveness of SG Total to positive and negative changes in firm market value. We also estimate the same regressions for TDC1 and SO Total. In both cases, we find no evidence of significant pay performance sensitivity for both men and women. This is consistent with previous work suggesting that only firm specific wealth is sensitive to firm performance (Baker and Hall, 2004) and that stock options display little pay performance sensitivity (Bebchuck and Fried, 2003).

The fact that for female executives firm specific wealth fluctuates less in response to changes in firm value does not necessarily imply that they are less exposed to changes in firm performance relative to male executives. This point can be illustrated with a simple back of the envelope calculation. We take the product of the estimated pay performance sensitivity coefficient and the average percentage change in firm market value as a fraction of average outstanding SG Total by gender. This relates the average change in SG Total linked to variations in firm performance to the average SG Total by gender, as a rescaling factor. We use the percentage changes for this exercise, as they are not sensitive to firm size. We perform the calculation for the absolute value of the percentage change in firm market value, and the positive and negative changes. The results are presented in Table 7.

The top panel in Table 7 presents some summary statistics on the percentage changes in market value. Notably, the average positive change is substantially higher than the average negative change, and 62% of all changes are positive. The bottom panel presents the exposure calculations by gender. Column (1) uses the estimates from Table 5. Rescaling by average SG Total substantially shrinks the gender gap in exposure to changes in firm market value, which is equal to 28% of average SG Total for female executives and 38% for male executives. Columns (2) and (3) use estimates from Table 6, which distinguishes between positive and negative changes in firm value. Female executives are less exposed to *positive* changes in firm market value and more exposed to *negative* changes in market value. The gender differences are very sizable, with female executives' exposure to positive changes in firm value being less than a third of male executives, and exposure to negative changes approximately twice as large as male executives'.[13] Taking the weighted average of columns (2) and (3), using the incidence of positive and negative changes, we obtain column (4), which captures the cumulated change in SG Total determined by changes in firm value over the sample period. We find that pay for female executives cumulatively declined by 16% as a result of exposure to changes in firm market value, while for male executives it cumulatively rose by 15% over the sample period. These calculations clearly articulate that although female executives receive lower incentive pay and have lower pay performance sensitivity, they experience greater exposure to negative changes in firm value and smaller exposure to positive changes in firm value compared to male executives, as a fraction of their average SG Total. Overall, changes in firm performance penalize female executives while they favor male

[11] These results suggest a much larger sensitivity to negative changes in firm value compared to positive changes for men. We conjecture that this may be due to the large declines in capitalization following the 2000 stock market crash. In Appendix B, we present results for a specification in which the years 2000 and 2001 are left out of the analysis (Table 12). Indeed, we find that the sensitivity to negative changes drops substantially, but none of the other estimates are sizably altered.

[12] To further investigate the presence of asymmetry between positive and negative changes, we also run a regression separately for positive and negative changes. The findings are consistent with the ones in which both are included jointly. The results for positive changes are displayed in Table 13 and for negative changes in Table 14 in Appendix B.

[13] This is consistent with Selody (2010), who also finds evidence of asymmetric exposure to positive and negative changes in firm performance for female and male executives.

Table 6: Pay Performance Sensitivity. Positive and Negative Changes. SG Total

	Dependent variable is: $\Delta SGTotal$			
	(1)	(2)	(3)	(4)
F	-273.8	-11,696	6,768	13,872
	(-0.0387)	(-0.821)	(0.947)	(0.899)
ΔV_+	19.62**	22.85**		
	(2.495)	(2.467)		
$F \times \Delta V_+$	-13.06**	-6.820		
	(-2.414)	(-0.943)		
ΔV_-	13.30	15.72		
	(1.582)	(1.578)		
$F \times \Delta V_-$	-14.53**	-18.78**		
	(-2.283)	(-2.358)		
ΔV_{agg}	-0.267	-0.205	0.185	0.311
	(-0.292)	(-0.171)	(0.226)	(0.284)
$F \times \Delta V_{agg}$	0.272	0.165	-0.452	-0.552
	(0.875)	(0.360)	(-1.477)	(-1.023)
$\%\Delta V_+$			55,391**	66,141**
			(2.225)	(2.203)
$F \times \%\Delta V_+$			-51,886**	-99,053
			(-2.145)	(-1.376)
$\%\Delta V_-$			92,605**	115,482**
			(2.456)	(2.429)
$F \times \%\Delta V_-$			-53,472*	-53,195
			(-1.871)	(-0.913)
Title		X		X
Age		X		X
Constant	226,813***	430,886**	118,085	287,259
	(2.823)	(2.518)	(1.120)	(1.431)
Observations	28,257	22,266	28,257	22,266
R^2	0.105	0.125	0.021	0.027

Notes: See Table 1 for variable definitions and data sources. All specifications control for firm and year effects, log real assets, and change in industry value. ΔV_+ and ΔV_- represent positive and negative changes in firm market value, respectively. Standard errors are clustered at the firm-year level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Executive's Exposure to Changes in Firm Market Value. SG Total

	$\|\%\Delta V\|$	$\%\Delta V_+$	$\%\Delta V_-$	
Mean	0.38	0.49	0.22	
St Dev	0.60	0.74	0.18	
Incidence		0.62	0.38	
	(1)	(2)	(3)	(4)
Exposure	$\|\%\Delta V\|$	$\%\Delta V_+$	$\%\Delta V_-$	Total
Female	0.28	0.13	0.63	−0.16
Male	0.38	0.44	0.33	0.15

Notes: Exposure is defined as $\beta_j\times$ Mean$\%\Delta V/(MeanSGTot_j)$ for $j = f, m$, where β_j is the estimated sensitivity from Table 5 (column 1) and Table 6 (columns 2 and 3). The exposure in column (4) is an average between columns 2 and 3 weighted by the incidence of positive and negative changes in firm market value.

executives.

2.5 Firm Performance by Gender

The final piece of evidence we report is on firm performance by gender. The results are collected in Table 8. We use four standard measures of firm performance: the ratio of market value to assets (Tobin's q ratio), returns on assets (ROA), and the percentage change in firm market value. Columns (1) to (3) present the results when we regress each of these measure against the share of females among the top-5 executives in each firm-year observation, columns (4) to (6) report the results when we control for whether the firm had a female CEO in any given year. All regressions control for time and year effects. We also control for the corresponding industry performance measure in each specification.

The results suggest that there are no significant differences in firm performance by gender. These findings are consistent with Catalyst (2004b) and Wolfers (2006). Wolfers analyzes 350 Fortune 500 companies in a broad range of industries and finds that the group of companies with the highest representation of women in their top management team experienced better performance than the group of companies ranked at the bottom in terms of female representation. This holds for two measures of performance, Return on Equity and Return to Shareholders, in the aggregate and by industry.[14]

[14] Bertrand and Schoar (2002) present evidence that "managerial style" influences not only performance but a broad range of corporate strategies such as capital structure, investment behavior, diversification policies and so on. Since managerial style can be interpreted as a collection of attributes and female and male executives differ in these attributes (see Section 3), it is possible that firm strategy varies based on the gender of the top executives, even if this is not reflected in systematic differences in performance.

Table 8: Firm Performance and Executives' Gender

Performance	(1) Tobin Q	(2) ROA	(3) % Δ MktVal	(4) Tobin Q	(5) ROA	(6) % ΔMktVal
$\%F$	-0.390*	-0.154	-0.0936			
	(-1.658)	(-0.101)	(-1.277)			
F^{CEO}				-1.600	-3.028	0.0924*
				(-0.991)	(-0.985)	(1.648)
Constant	1.187***	4.742***	0.0826***	1.181***	4.836***	0.0759***
	(7.674)	(16.32)	(6.302)	(7.505)	(16.28)	(5.957)
Observations	14,012	14,078	12,634	13,710	13,772	12,400
R-squared	0.481	0.358	0.186	0.482	0.378	0.192

Notes: See Table 1 for variable definitions and data sources. Robust t-statistics in parentheses. All specifications include year effects and firm fixed effects. For each firm performance measure, we control for the corresponding industry analog performance measure. Errors are clustered at the firm-year level. *** p<0.01, ** p<0.05, * p<0.1

3 Evidence of Gender Differences in Executive Labor Markets

We begin exploring the possible determinants of the gender differences in the structure of pay for top executives by reviewing the evidence on gender differentials in characteristics that could be relevant for the executive labor market. We examine three types of evidence: surveys of professionals and executives eliciting information on barriers to career advancement, time use evidence on household allocation of child care responsibilities for top income earners, and experimental and psychological studies of performance in competitive environments, propensity to compete and initiate negotiations and risk aversion. Taken together, the evidence can be summarized as follows:

- Exclusion from informal networks, gender stereotyping and lack of role models are perceived as substantial barriers to career advancements for female executives.
- Married women in the top 5% of the income distribution bear a disproportionately large share of child care responsibilities relative to married men in similar circumstances.
- Women display lower performance in competitive environments, even with no differences in performance in non-competitive setting, and lower propensity to select into competitive environments.
- Women display lower propensity to initiate negotiations.
- Women exhibit higher risk tolerance to abstract gambles, but there are no gender differences in risk aversion in contextual financial settings.

3.1 Surveys on Barriers to Career Advancement.

Surveys of top executives suggest that female executives may experience greater difficulties relative to men in corporate leadership roles. Catalyst (2004a) studies self-reported barriers to career advancement by gender for professionals in top management positions. The main findings are reported in table 9 below.

The lack of role models and the exclusion from informal networks, in addition to gender based stereotyping, are associated with the greatest gender difference.[15] Gender asymmetries in commitment to personal and family responsibilities are significant but appear small from these results. This may be due to the fact

[15] Plummer and Lindenlaub (2014) suggest that female networks may differ from male networks. This may induce exclusion in male dominated work environments.

Table 9: Barriers to Career Advancement

Barrier	Male	Female
Lack of mentoring*	16%	25%
Lack of role models**	13%	43%
Exclusion from informal networks**	18%	46%
Gender based stereotyping**	5%	46%
Inhospitable corporate culture**	13%	24%
Commitment to personal/family*	8%	15%
*p value=0.05, **p value=0.01		

that professional and executive women are more likely to be childless or not married than men. Hewlett (2002) reports that, in her sample of high earning (above $100 thousand) executives and professionals, 83% of male and only 57% of women are married. Moreover, 19% of male and 49% of female respondents are childless. The fact that the prime childbearing years overlap with the critical career building years may in part be responsible for this outcome and suggests that the gender asymmetries in the personal cost of career investments may be quite substantial.

Evidence in Hewlett (2002) also suggests that gender asymmetries in the allocation of family responsibilities may be quite substantial for married women in the sample. Among the married professionals and top executives, only 39% of men are married to women who are employed full time, and 40% of these spouses earn less than $35 thousand a year. On the other hand, 90% of women in the high achieving category have husbands who are employed full time or self-employed, and 25% are married to men who earn more than $100 thousand a year. Among her sample of high achieving women with husbands working full time, 51% take time off for child sickness, while only 9% of men do. Similarly, 61% of women are mainly responsible for organizing child activities, while only 3% of men bear this responsibility.

These results lead us to consider more systematic evidence on the allocation of child care and family responsibilities for high earning individuals using time use data.

3.2 Time Use for Top Income Earners

Table 15 reports information on weekly hours spent in child care activities, as well as total home[16] and market hours for workers in the top 5% of the income distribution in the American Time Use Survey (ATUS). The sample has been selected to reflect the characteristics of individuals in the ExecuComp data set as closely as possible while maximizing the number of observations. The sample includes 171 women and 496 men. We also report information for the overall population to facilitate comparisons.

Two main facts emerge from the analysis of the table:

- Gender differences in total weekly hours spent in home production activities are smaller for top earners than in the overall population. For the sample of married men and women the ratio of female to male home hours is 1.38 (column 5) and 1.73 in the overall population (column 1).
- Gender differences in time spent in the care of children do not vary much by income. The ratio of female to male hours of child_care_full for married individuals is 2.4 for top 5% income earners and 2.3 in the overall population. For the top 5% of earners, married women with children under 5 spend 25.2 hours per week on child care, while married men only spend 10.2 hours (column 9).

[16]Home production measures exclude any child care related hours in ATUS.

This analysis cannot be directly brought to bear on the sample of top executives in ExecuComp due to top coding of incomes in ATUS. Yet, the substantial gender asymmetry in child care responsibility may ultimately affect women's career advancement and exert a permanent effect on their behavior in market work.

3.3 Evidence on Gender Differences in Preferences

There is a large and active experimental literature exploring gender differences in preferences. The literature is extensively and critically reviewed in Bertrand (2010), Niederle (forthcoming) and Azmat and Petrongolo (forthcoming). Here, we summarize the main findings to frame the discussion is Section 4.

Performance in Competition and Propensity to Compete Experimental evidence suggests that women may be less effective than men in competitive environments, even if they demonstrate the same ability to perform in noncompetitive environments (Gneezy, Niederle and Rustichini, 2003). In addition, women have lower propensity to select into competitive environments (Niederle and Vesterlund, 2007) and seek challenges (Niederle and Yenstruskas, 2007).

Propensities to Initiate Negotiations Babcock and Laschever (2003) present a variety of evidence, in the form of surveys, case studies and interviews, suggesting that women exhibit lower propensity to initiate negotiations. These findings are refined in a variety of experimental settings.[17] Consistently, women asked for greater compensation much less often than men. Social incentives and situational factors appear to play a critical role, based on the differential treatment of men and women when they attempt to negotiate.

Risk Aversion Survey evidence and field studies based on asset allocations suggest that women have higher risk aversion than men.[18] However, survey respondents are prone to evaluate the risks they are confronted with based on their individual opportunity sets, and controls for individual wealth and earnings are either weak or absent from the analysis. There is also a sizable experimental literature with findings broadly consistent with higher risk aversion for women (see Croson and Gneezy, 2009, and Eckel and Grossman, 2008). Even if this evidence is rather inconclusive (Niederle, forthcoming), some systematic patterns increases confidence in these results. For example, lack of confidence can result in reduced tolerance towards risk (Bertrand, 2010) and women's lower propensity to initiate negotiation is also consistent with male overconfidence. Moreover, the findings in economics are consistent with psychological evidence on gender differences in risk taking.[19]

The available evidence is broadly consistent with a systematic difference in preferences across genders. Yet, high level managers undergo a severe process of (self-)selection, thus one would expect them to exhibit a comparative advantage in essential traits, such as ability to form and join networks, perform in

[17] See Riley and Babcock (2002), Small, Gellman, Babcock and Gettman (2005) and Bowles, Babcock, and Lai (2005).

[18] Barsky, Juster, Kimball, and Shapiro (1997) find that females display smaller risk tolerance than males based on survey responses in the Health and Retirement Study. Portfolio evidence also suggests that wealth holdings of single women are less risky than those of single men of equal economic status (Jianakoplos and Bernasek, 2009, and Sunden and Surette, 1998).

[19] The strongest support for gender differences in risk attitudes in the psychological literature comes from patterns of risky sex and risky driving behavior. See Byrnes, Miller, and Schafer (1999).

competitive environments, propensity to negotiate and to embrace risk.[20] Even if gender differences in preferences are small for this group, combined with additional systematic differences, such as the costs of career investments or weight of family responsibilities, they may influence an executive's ability to influence firm performance or effect the value to the executive of a given compensation package.

To explore the effects of these factors on executive compensation, we view the pay setting process as an agency problem. In Section 4, we explore the efficient contracting paradigm of executive compensation and the skimming or executive power view to assess whether they can rationalize some of the gender differences in executive pay.

4 Executive Compensation Paradigms: Efficient Contracting vs Managerial Power

In this section, we compare two paradigms for executive compensation. The first is the efficient benchmark, based on a dynamic moral hazard model in which shareholders set pay for top firm executives to optimally trade-off insurance and incentive provision. The second is based on recent evidence that managerial compensation is not efficient, and is instead driven by the entrenched managers who hold board captives and are able to set the terms of their own pay. We will then assess − based on the differences in preferences and entrenchment between female and male executives − which paradigm can rationalize the gender differences in compensation structure for top executives described in Section 2.

4.1 Efficient Contracting Benchmark

We start from the benchmark efficient paradigm for executive compensation which is based on the *arm's length* model of interaction between shareholders and executives. The shareholders (principals) hire an executive (agent) to manage the firm. They set executive compensation to maximize the surplus from the executive-firm relationship. Time, t, is discrete. The executive's effort, e_t, influences the growth in firm value, V_t, according to the law of motion:

$$V_{t+1} - V_t = b\left(V_t\right) e_t + \omega\left(V_t\right). \tag{3}$$

The term $b\left(V_t\right) e_t$ corresponds to the expected change in firm value, and the parameter $b\left(V\right)$ represents the impact of the executive's effort, or the marginal product of managerial effort. The term $\omega\left(V_t\right)$ is a random variable distributed normally with zero mean and standard deviation $\Sigma\left(V_t\right) > 0$. Following Baker and Hall (2004), both the expected change in firm value and its volatility are allowed to depend on firm value, which is a proxy for size.

The executive's preferences are represented by the utility function:

$$U\left(w, e\right) = -\exp\left(-\sigma\left[w - \theta v\left(e\right)\right]\right), \tag{4}$$

where w corresponds to earnings. The coefficient of absolute risk aversion is $\sigma > 0$, and $v\left(\cdot\right)$ denotes the disutility of effort, where $e \in [0, 1]$. The function v is increasing, twice continuously differentiable and convex. The parameter $\theta > 0$ represents the cost of effort for the executive. We adopt a CARA utility specification to allow for a closed form solution.

[20]In a natural field experiment with college students, Samek (2015) ratifies the finding that women are deterred by performance based compensation schemes more than men, controlling for risk preferences. However, when controlling by major, she finds that students of Business and Engineering of both genders strongly prefer a competitive scheme.

A moral hazard problem arises since effort, e, is *private information*. Effort should be interpreted broadly, as any action that increase firm value but generates a non-pecuniary cost for the executive. In a literal interpretation, low values of effort would correspond to shirking. Alternatively, lower values of effort 1 can be interpreted as an action that reduces firm value but generates private benefits for the executive, such as perks.

The change in firm value, $V_t - V_{t-1}$, is *observable*. The optimal compensation contract specifies an effort level and an earnings function, linking earnings, w, to the change in firm value $\Delta V_t = V_t - V_{t-1}$. Since the change in firm value is the only observable measure of the executive's performance, a dependence of earnings on this variable is essential for the contract to implement strictly positive effort, given the agency problem.

The expected surplus from the firm-executive relationship is equal to its certainly equivalent:

$$ES(e) = b(V)e - \theta v(e) - \sigma (\Sigma(V))^2 (\tilde{w})^2 /2. \tag{5}$$

The first term is expected change in firm value, the second term is the utility cost of exerting effort for the executive. The last term corresponds to the reduction in the executives' utility due to the fact that her earnings depend on firm performance and are thus stochastic. If the executive is risk averse, that is $\sigma > 0$, the resulting earnings volatility reduces her utility.

The optimal compensation contract maximizes the expected surplus from the shareholder-executive relationship subject to an incentive compatibility and a participation constraint for the executive, which reflects the executive's outside option. The optimal contract specifies the executive's earnings as a function of the observable change in firm value. As shown in Holmstrom and Milgrom (1991), CARA utility implies that, without loss of generality, we can restrict attention to earnings functions of the form: $w(\Delta V) = \bar{w} + \tilde{w}\Delta V$, where $\bar{w}$ corresponds to cash salary and $\tilde{w}\Delta V$ is incentive pay. The incentive pay component, $\tilde{w}\Delta V$, can be taken to correspond the sum of of all components of compensation that are sensitive to firm performance, such as bonus programs and restricted stock and stock options grants. The linear structure of the model delivers the following predictions for the growth in executive earnings:

$$\Delta w_t = \Delta \bar{w}_t + \tilde{w}(\Delta V_t - \Delta V_{t-1}).$$

where $\Delta w_t = w_t - w_{t-1}$. Thus, $\tilde{w}$ corresponds to pay-performance sensitivity.[21]

We describe all the remaining analytical details pertaining to the derivation of the optimal compensation contract in Appendix C. Proposition 1 describes the properties of the optimal compensation contract as a function of the executive's attributes, which, together with some firm characteristics, determine whether effort is maximized or interior. The proposition is stated formally in the appendix. Here, we simply restate the properties of the optimal contract salient to our analysis, in comparative statics terms.

Properties of the optimal compensation contract Proposition 1 delivers the following comparative statics results on the link between optimal compensation and the executive's attributes for given firm size for interior effort:

[21] This has a direct counterpart in the conventional pay-performance sensitivity regression:

$$\Delta w_t = \alpha_0 + \alpha_1 \Delta V_t + \varepsilon_t.$$

This specification implies that $\alpha_0 = \Delta \bar{w}_t - \tilde{w}\Delta V_{t-1}$ and $\alpha_1 = \tilde{w}$ under the null that the model is true.

- Optimal effort is maximized if and only if:

$$\frac{\theta}{b(V)}\left(1+\frac{\sigma}{b(V)}\frac{\Sigma^2}{b(V)}\right)\leq 1. \tag{6}$$

- If optimal effort is interior:
  - Effort is increasing in b and declining in θ, σ and Σ.
  - Pay-performance sensitivity, $\tilde{w}$, is increasing in b and declining in θ, σ and Σ.
  - Cash salary, $\bar{w}$, and total compensation, w, are increasing in b and decreasing in θ, σ and Σ, as well as increasing in u.
- If optimal effort is maximized:
  - Pay-performance sensitivity, $\tilde{w}$, is increasing in θ and declining in b. It does not vary with σ and Σ.
  - Cash salary, $\bar{w}$, and total compensation, w, are decreasing in b and increasing in θ, σ and Σ, as well as increasing in u.

The value of $b(V)$ is critical for the optimal value of effort. Given the executive's cost of effort and risk aversion, θ and σ, and the performance volatility, Σ^2, effort will be maximized when the impact of the executive's effort on the change in firm value is sufficiently large.

The cost of providing incentives is increasing in θ and σ and declining in b. Moreover, higher volatility of the change in firm value, Σ, reduces the ability of the observed change in value to serve as a signal for the executive's effort, making the moral hazard problem more severe. Therefore, optimal effort is maximized when the effectiveness of the executive, b, is high enough relative to the cost of providing incentives.

The optimal structure of compensation depends on whether effort is maximized. When effort is interior, the impact of the executive on firm performance via effort is relatively low. Since it is costly to incentivize the executive, the optimal effort will be declining in θ, σ and Σ, and so will be the fraction of incentive pay, salary and total compensation. Since salary, $\bar{w}$, does not influence the executive's effort, it does not enter the surplus and only influences its division between the firm and the executive. The salary is increasing in b, decreasing in θ, σ, and Σ, and increasing in u. The same comparative statics relationships holds for overall compensation, w.

If effort is maximized, then the executive has high impact and the optimal contract compensates the executive for exerting the maximum effort in an incentive compatible fashion by making incentive pay and total compensation decreasing in b and increasing in the executive's cost of effort θ. It does not depend on the executive's risk aversion or Σ. A higher value of b generates an intrinsically high sensitivity of firm performance to the executive's effort, and thus reduces the level of $\tilde{w}$ required to implement the maximum effort. By contrast, a higher cost of effort requires higher sensitivity of pay to firm performance to induce the executive to exert the maximum effort level. Salary and total compensation are also increasing in θ and declining in b, as well as increasing with both σ and Σ.

By equation (15), effort is maximized for $b(V)/\theta$ large enough. Thus, the elasticity of $b(V)$ with respect to firm value V is a critical parameter. Moreover, in this framework, firm value also corresponds to firm size. To fully characterize the structure of the optimal contract, specifically, the dependence of salary and incentive pay on the executive's attributes, we embed the efficient contracting model into an equilibrium assignment model. Following Baker and Hall (2004), we assume:

$$b(V) = bV^{\gamma}, \tag{7}$$

$$\omega(V) = \omega V^{\gamma}, \tag{8}$$

where $b, \omega > 0$ and $\gamma \in [0,1]$ corresponds to the elasticity of the impact of effort on firm performance. This flexible formulation allows us to capture most cases considered in the literature. If this elasticity is zero, then the marginal product of executive effort is invariant to firm size. At the other extreme, if the marginal product of effort varies one to one with firm size, the impact of effort will rise with firm size. This assumption underlies the classic span of control models of Lucas (1978) and Rosen (1982). The power of incentives corresponds to the change in expected pay perceived by the executive as effort changes, and with this formulation it corresponds to $\tilde{w}bV^{\gamma}$, which depends on whether effort is maximized and on firm value.

The optimal firm size distribution of executives maximizes economy wide surplus, as described in detail in Appendix C, by assigning value to executives with different attributes. The solution to the assignment problem is described in Proposition 2. The main results in that proposition are that if optimal effort is interior, all executives will be assigned strictly positive firm value. The optimal value is increasing in b for $\gamma < 1$. By contrast, when effort is maximized, executives with undesirable characteristics will not be assigned a strictly positive firm value. The highest ranked executive will be assigned all the value outstanding capital.

The properties of the optimal assignment problem suggests that the case in which the optimal level of effort is 1 is non generic, as it corresponds to a situation in which the most desirable executive manages all capital. For this reason, we restrict attention to the predictions of the model with interior optimal effort for the rest of our discussion.

Hypothesis Regarding Gender Differences The empirical evidence discussed in Section 3 suggests that executive women are less able to be included in professional networks and find mentors, and they experience higher costs of career investments and bear a larger share of child care responsibilities. Moreover, women show lower propensity to compete and initiate negotiations, and they display lower risk tolerance.

The executive labor market is highly competitive, entails constant negotiations, involves bearing risk and is mostly male. Networking and mentoring are seen as key to professional advancement. In addition, a high number of work hours is required, making it hard to reconcile these positions with responsibilities outside of work. Thus, if the gender differences described in Section 2 are present among top executives, they may exert a significant influence on women's performance on the executive labor market. We now discuss a possible mapping between these gender differences discussed in Section 3 and the vector of executive attributes in the agency model $n = \{b, \sigma, \theta, u\}$.

Female executives' lack of access to professional networks and mentors could both reduce their impact on firm value b, and increase their cost of managerial effort θ. Women's higher cost of career investment and greater burden of family responsibility could be taken to correspond to higher value of θ for female executives relative to males.

Women's lower propensity to compete or engage in negotiations may be represented as entailing a higher utility cost of exerting managerial effort, that is a higher value of θ for female executives. These traits could also reduce the impact of effort on firm performance, that is the parameter b. Higher θ or lower b would both lead to lower incentive pay as a share of total compensation and lower pay-performance sensitivity, for given firm size.

The evidence on women's lower risk tolerance implies a higher coefficient of relative risk aversion for female executives. As discussed in Baker and Hall (2004), there is an inverse relation between absolute risk aversion and the executive's wealth, for given coefficient of relative risk aversion, σ^R:

$$\sigma = \sigma^R / W,$$

where W is the executive's wealth. The female executives' lower earnings would imply a lower value of wealth, which would determine a higher value of their coefficient of absolute risk aversion.

The executive's outside option u only influences the level of cash salary and total earnings. There is no direct connection between the evidence in gender differences may influence u. If the outside option corresponds to the next best executive position, women's reported greater difficulties in accessing professional networks, may entail lower values of u for women.

To summarize, the empirical findings on the gender differences in structure of compensation are consistent with female executives having low b, high θ and σ relative to men. Should we then conclude that the gender differences in pay in the executive labor markets are efficient? Such a conclusion would be unwarranted, given that the efficient contracting model cannot account for many of the empirical findings we discuss in Section 2. First, after conditioning on all observables, we do not find any significant differences in firm performance in relation to the female presence in executive positions. The efficient model predicts that lower effort will be implemented for executives with lower b or higher σ and θ, leading to lower average performance, as measured by the change in firm value. This contradicts the evidence. The efficient model predicts that women should receive lower fraction of incentive and exhibit lower pay-performance sensitivity, as we find in the data. However, the model cannot explain why female top executives are less exposed to good firm performance and more exposed to bad in firm performance relative to males.

We now turn to an alternative model of executive compensation to examine these issues.

4.2 Alternative Views of the Pay-Setting Process

The efficient contracting approach to executive compensation assumes that compensation packages are generated by *arms length contracting* between executives and a principal, possibly representing the board of directors, who seek to maximize the value of the firm for shareholders. However, Bebchuk and Fried (2003 and 2005) criticize this approach and propose instead that executive compensation depends on managerial power. The heart of their hypothesis is that board members also face an agency problem, which implies that they cannot be taken to make decisions to maximize the shareholders' value. Then, executives can influence their compensation package to increase average pay and undermine incentives. Bertrand and Mullainathan (2001) refer to this paradigm as *skimming* and suggest that in this case CEOs can act like "agents without principals." Such behavior may give rise not only to higher average executive pay but also to distortions to incentives, such as rewarding for growth in size, low sensitivity to firm performance, excessive risk taking and so on.

Bebchuk and Fried (2003) summarize the factors that may make board members sensitive to executive power when setting compensation packages. These include the incentive to be re-elected, the CEO's ability to reciprocate directors for favors, participation in informal networks leading to loyalty and incentives for reciprocity towards the executive by the board, cognitive dissonance stemming from executive positions currently or previously held by board members, and ratcheting resulting from competition on executive labor markets. They argue that market forces do not have the ability to restrain these enabling factors.

According to this view, the only social stigma faced by executives who receive disproportionately large compensation may limit the degree to which CEOs can exert influence over their own pay. This leads to efforts on part of executives to camouflage their earnings, by using stock options and other less visible forms of compensation, such as executive pension plans, deferred compensation and post-retirement perks (Kuhnen and Zwiebel, 2009). The social costs of increasing top executive compensation may vary with aggregate stock market performance and decline in good times. Thus, executive compensation may rise more steeply in periods of good firm and stock market performance. The level and structure of executive pay will also be sensitive to corporate governance variables.

Pay-Perfomance Links The managerial power or skimming view predicts that the links between executive pay and firm performance will be weak. It argues that components of compensation that are officially presented as incentive pay, may easily be structured so that they do not expose the executive to bad firm performance. In particular, equity based compensation can be designed so that executives executive can gain from *any* increase in the nominal value of the stock price above the grant-date market value. This implies that executives can experience gains in pay even if their firm performs below the relevant peer group, as long as market-wide and industry-wide movements provide sufficient lift for the stock price. Thus, compensation will be more sensitive to increases in firm value than declines, and should increase with aggregate market value and other factors that positively affect firm performance but are completely outside the scope of influence top executives. Results in Bertrand and Mullainathan (2001) suggest that CEOs are indeed rewarded for these factors.

Kuhnen and Zwiebel (2009) provide a formalization of this view and derive the implications for the relation between executive attributes and the structure of pay. Their analysis focusses on the *hidden* components of pay. They posit that direct salary and bonuses are the most observable components of compensation, while other forms of pay are hidden. The main predictions of their theoretical analysis are that hidden pay is increasing in the noise in the production process (corresponding to Σ in the notation introduced in Section 4.1), the manager's outside option (corresponding to u) and decreasing in the uncertainty over the manager's ability or talent (corresponding to b), which they proxy with the inverse of a manager's tenure in their empirical analysis. Their results are strongly supportive of the model's prediction for a sample of CEOs.

We now use the findings in Section 2 to assess the skimming view of executive pay.

Gender and Managerial Power The fact that female top executives perceive limited access to informal networks, gender stereotyping, an inhospitable corporate culture, jointly with their younger age and lower tenure, suggests that they might be considerably less entrenched and exert lower control on their own compensation than their male counterparts on average. It follows that, if the skimming view is correct, female compensation packages should display fewer of the features that are predicted by the managerial power model.

The evidence on the structure of pay and pay-perfomance sensitivity is consistent with this hypothesis. We find that female executives have much lower incentive/hidden pay in the form of stock options, stock grants and firm specific wealth. Moreover, while female top executives experience lower pay performance sensitivity than male top executives, female executives reap a lower gain in case of positive firm performance relative to male executives, and experience larger declines in firm specific wealth in case of declines in firm performance.

5 Concluding Remarks

The efficient contracting model can rationalize several of the gender differences in the structure of compensation for top executives, based on the experimental and survey evidence on gender differences in preferences and costs of managerial effort. However, the efficient compensation contract, reflecting these perceived differences in attributes, would induce lower effort for female managers, resulting in lower effective performance relative to males. We find no differences in measured firm performance based on the percentage of women in top executive positions. The efficient contracting paradigm also fails to explain why female executives' earnings are more exposed to bad firm performance. The managerial power/skimming view of executive compensation can rationalize these differences based on the notion that female top executives are less entrenched than male top executives, due to their younger age and their relative difficulties in accessing informal networks.

These two views of the pay-setting process lead to a very different assessment both of the level and structure of pay for top executives. Under the efficient contracting paradigm, the gender differences in pay are optimal based on the gender differences in attributes. The lack of representation of women in top executive positions is inconsequential. Based on the skimming view, the gender differences in pay do no reflect any performance relevant characteristic, but different degrees of managerial power of female and male executives. Based on this explanation, it would be optimal to have more women in top executive positions, even if they have less desirable attributes as managers, as long as they remain less entrenched than men. More broadly, the fact that the skimming view is able to rationalize more of the gender differences in the level and structure of pay raises additional questions about the validity of the efficient contracting paradigm.

References

[1] Mark Aguiar and Erik Hurst, 2007. Measuring Trends In Leisure: The Allocation Of Time Over Five Decades. *Quarterly Journal of Economics* 122 (3): 969-1006.

[2] Stefania Albanesi and Claudia Olivetti, 2009. Home production, market production and the gender wage gap: Incentives and expectations. *Review of Economic Dynamics* 12 (1): 80-107.

[3] Ghazala Azmat and Barbara Petrongolo, 2015. Gender and the labor market: What have we learned from field and lab experiments? Forthcoming, *Labour Economics.*

[4] Linda Babcock and Sara Laschever, 2003. *Women Don't Ask: Negotiation and the Gender Divide* Princeton University Press.

[5] George Baker and Brian Hall, 2004. CEO Incentives and Firm Size. *Journal of Labor Economics* 22(4): 767-798.

[6] Lucian A. Bebchuk and Jesse M. Fried, 2003. Executive Compensation as an Agency Problem. *The Journal of Economic Perspectives* 17(3): 71-92.

[7] Lucian A. Bebchuk and Jesse M. Fried, 2005. Pay Without Performance: Overview of the Issues. *Journal of Applied Corporate Finance* 17(4): 8-23.

[8] Linda A. Bell, 2005. Women-Led Firms and the Gender Gap in Top Executive Jobs. *IZA DP No. 1689*

[9] Marianne Bertrand, 2011. New Perspectives on Gender. *Handbook of Labor Economics* 4: 1543-1590.

[10] Marianne Bertrand and Kevin Hallock, 2001. The Gender Gap in Top Corporate Jobs. *Industrial and Labor Relations Review,* Vol. 55, No.1.

[11] Marianne Bertrand and Sendhil Mullainathan, 2001. Are CEOs Rewarded for Luck? The Ones Without Principlas Are. *Quarterly Journal of Economics* 116(3): 901-932.

[12] Marianne Bertrand and Antoinette Schoar, 2003. Managing With Style: The Effect of Managers on Firm Policies. *Quarterly Journal of Economics* 118(4): 1169–1208.

[13] James Byrnes, David Miller and William Schafer. 1999. Gender Differences in Risk Taking: A Meta-Analysis. *Psychological Bulletin* 125(3): 367-383.

[14] Catalyst, 2004a. Women and Men in U.S. Corporate Leadership.

[15] Catalyst, 2004b. The Bottom Line: Connecting Corporate Performance and Gender Diversity.

[16] Rachel Croson, and Uri Gneezy. Gender differences in preferences. Journal of Economic literature (2009): 448-474.

[17] Catherine C. Eckel and Philip J. Grossman. Differences in the economic decisions of men and women: Experimental evidence. Handbook of experimental economics results 1 (2008): 509-519.

[18] Alexander Edmans, Xavier Gabaix, and Augustin Landier. 2007. A Calibrated Model of Optimal CEO Incentives in Market Equilibrium. NBER WP 13372.

[19] Xavier Gabaix and Augustin Landier, 2007. Why has CEO pay Increased so much? Quarterly Journal of Economics.

[20] George-Levy Gayle, Limor Golan and Robert A. Miller, 2012. Gender Differences in Executive Compensation and Job Mobility. *Journal of Labor Economics*, Vo. 30(4): 829-71.

[21] Uri Gneezy, Muriel Niederle, and Aldo Rustichini, 2003. Performance in Competitive Environments: Gender Differences. *Quarterly Journal of Economics* CXVIII: 1049 – 1074.

[22] Brian J. Hall; Kevin J. Murphy, 2003. The Trouble with Stock Options. *The Journal of Economic Perspectives*. 17(3): 49-70.

[23] Sylvia A. Hewlett, 2002. Executive Women and the Myth of Having It All. *Harvard Business Review*.

[24] Charles P. Himmelberg and R. Glenn Hubbard, 2000. Incentive Pay and the Market for CEOs: An Analysis of Pay-for-Performance Sensitivities, Presented at Tuck-JFE Contemporary Corporate Governance Conference. Available at SSRN: http://ssrn.com/abstract=236089.

[25] Bengt Holmstrom, 1979. Moral Hazard and Observability. *Bell Journal of Economics* X: 74-91.

[26] Michael C. Jensen and Kevin J. Murphy, 1990. Performance Pay and Top-Management Incentives, *Journal of Political Economy*, Vol. 98, 225-264.

[27] Nancy Jianakoplos and Alexandra Bernasek, 1998. Are Women More Risk Averse? *Economic Inquiry* 36: 620-630.

[28] Camelia Kuhnen and Jeffrey Zwiebel. 2009. Executive Pay, Hidden Compensation and Managerial Entrenchment. Manuscript, UNC.

[29] Peggy Lee and Erika James, 2003. She-E-Os: Gender Effects and Stock Price Reactions to the Announcements of Top Executive Appointments. Darden Business School Working Paper 02-11.

[30] Thomas Lemieux, W. Bentley MacLeod and Daniel Parent, 2009. Performance Pay and Wage Inequality. *The Quarterly Journal of Economics* 124(1): 1-49.

[31] Robert E. Lucas, 1978. On The Size Distribution of Business Firms. *The Bell Journal of Economics* 9(2): 508-523.

[32] Nancy Mohan and Carl Chen, 2004. Are IPOs Priced Differently Based on Gender? *Journal of Behavioral Finance* 5(1): 57-65.

[33] Kevin J. Murphy, 1986. Incentives, Learning, and Compensation: A Theoretical and Empirical Investigation of Managerial Labor Contracts, *The Rand Journal of Economics*, Vol. 17, 59-76.

[34] Muriel Niederle. Gender. *Handbook of Experimental Economics*, second edition. Eds. John Kagel and Alvin E. Roth, forthcoming.

[35] Muriel Niederle and Lise Vesterlund, 2007. Do Women Shy Away from Competition? Do Men Compete too Much?, *Quarterly Journal of Economics*, forthcoming, August.

[36] Ilse Prummer and Anja Lindenlaub, 2014. Gender, Social Networks, and Performance. Cambridge-INET Institute Working Paper No.12.

[37] Sherwin Rosen, 1982. Authority, Control, and the Distribution of Earnings. *The Bell Journal of Economics* 13(2): 311-323.

[38] Anya Samek, 2015. A University-Wide Field Experiment on Gender Differences in Job Entry Decisions. Manuscript, UWM.

[39] Michael Sattinger, 1993. Assignment Models of the Distribution of Earnings. *Journal of Economic Literature* 31(2): 831-880.

[40] Karen Selody, 2010. Is the risk worth the reward for female executives? Manuscript, Department of Economics, University of California, Berkeley.

[41] Deborah Small, Michele Joy Gelfand, Linda C. Babcock and Hilary Gettman, 2005. Who Gets to the Bargaining Table? Understanding Gender Variation in the Initiation of Negotiations. IACM 17th Annual Conference Paper.

[42] Annika Sunden and Briasn Surette, 1998. Gender differences in the allocation of assets in retirement savings plans. *American Economic Review* 88(2): 207-11.

[43] Marko Tervio, 2007. The Difference that CEOs Make: An Assignment Model Approach. Manuscript, University of California, Berkeley.

[44] Cheng Wang, 1997. Incentives, CEO Compensation, and Shareholder Wealth in a Dynamic Agency Model, *Journal of Economic Theory*, Vol. 76, 72-105.

[45] Justin Wolfers, 2006. Diagnosing Discrimination: Stock Returns and CEO Gender. *Journal of the European Economic Association* 4(2-3): 531-541.

A Data Appendix

A.1 Sample selection

Our sample is built according to the following criteria:

- Execucomp sample 1992-2005. This is because 2006 disclosure reform which makes data on TDC1, Stock Options and Stock Grants not fully comparable to pre-2006 data.
- Excludes firms who are not in the S&P500, S&P MidCap 400 and S&P Small Cap 600.
- We drop duplicate observations based on the following variables: "gvkey year co_per_r tcc tdc1 tdc2 salary bonus shrown_t shrown_1 opt_unex opt_une1 othann ltip allothto pgender age."
- We restrict the analysis to the sample of "Top 5" executives: Chair/CEO, Vice Chair, Presidents, CFOs and COOs. We only include executives with positive compensation.

This selection criteria delivers a sample of approximately 40,000 observations (depending on the variable) for which detailed data on the structure of the executive compensation, his/her demographic characteristics as well as measures of the firm's market performance are available.

A.2 Variable Definition

We use ExecuComp information on the different components of pay to construct two sets of variables. The first includes all the flow components of pay, while the second includes two constructs that measure the executive's stock of wealth. All the variables are based on the 1992 definitions and are available for the entire 1992-2005 ExecuComp sample.

We consider the following components of compensation from ExecuComp

- TCC = Salary + Bonus, where:
  - Salary=Dollar value of base salary (cash and non-cash)
  - Bonus=Dollar value of bonus (cash and non-cash)

- TDC1 = TCC + SO + SG + OP, where:

- Stock options (SO) = OPTION_AWARDS_BLK_VALUE. This is the aggregate value of all the stock options granted to the executive during the year as valued using the S&P's Black Scholes methodology. The time-to-expiration date for most stock options granted varies between nine and ten years.
- Stock grants (SG) = RSTKGRNT. This is the value of restricted stock granted during the year (determined as of the date of the grant).
- Other Pay (OP) = OTHANN+LTIP+ALLOTHTO
  - OTHANN: OTHER ANNUAL. This is the dollar value of other annual compensation not properly categorized as salary or bonus. This includes items such as: 1) Perquisites and other personal benefits; 2) Above market earnings on restricted stock, options/SARs or deferred compensation paid during the year but deferred by the officer; 3) Earnings on long-term incentive plan compensation paid during the year but deferred at the election of the officer; 4) Tax reimbursements; 5) The dollar value of difference between the price paid by the officer for company stock and the actual market price of the stock under a stock purchase plan that is not generally available to shareholders or employees of the company (Note: This does not include value realized from exercising stock options).
  - LTIP: This is the amount paid out to the executive under the company's long-term incentive plan. These plans measure company performance over a period of more than one year (generally three years).
  - ALLOTHTOT: This is the amount listed under "All Other Compensation" in the Summary Compensation Table. This is compensation that does not belong under other columns, which includes items such as: 1) Severance Payments; 2) Debt Forgiveness; 3) Imputed Interest; 4) Payouts for cancellation of stock options; 5) Payment for unused vacation; 6) Tax reimbursements; 7) Signing bonuses; 401K contributions; Life insurance premiums.

- Stock grants (SGtot) = SHROWN_EXCL_OPTS x PRCCF = "Shares Owned - Options Excluded" x "The close price of the company's stock for the fiscal year"
- Stock options (SOtot) = OPT_UNEX_EXER_EST_VAL + OPT_UNEX_UNEXER_EST_VAL ="Estimated Value of In-the-Money Unexercised Exercisable Options ($)" + "Estimated Value Of In-the-Money Unexercised Unexercisable Options ($)"

We use the following Compustat variables to measure firm size:

- MKTVAL= Firm's market value as the close price for the fiscal year multiplied by the company's common shares outstanding
- ASSETS =The Total Assets as reported by the company.

Our measure of firm performance is the ExecuComp variable:

- ROA= RETURN ON ASSETS. This is the Net Income Before Extraordinary Items and Discontinued Operations divided by Total Assets.

All the components of executive compensation are expressed in thousands of dollars. Market value, assets and operating income are expressed in millions of dollars. All the nominal variables are deflated using the CPI with base 2000 from the BLS.

The age and tenure of top executives are based on the age in the most recent fiscal year (P_AGE_2) and on the year in which the executive joined the firm (JOINED_C), respectively.

Job "Titles" We construct a variable 11 occupational categories based on the "title" variables in ExecuComp (TITLE, which shows the most recent title, and TITLEANN, which shows the title in a given fiscal year). Among this we select our top-5 categories.

We construct the "title" variable as follows:

a. The dataset has two title variables – TITLE, which shows the most recent title, and TITLEANN, which shows the title in a given fiscal year. The former has less than 300 missing values, while the latter has almost 40,000. The two variables have discrepancies even in the most recent year. TITLEANN is used as the basis of all title variables. However, whenever it is missing in the most recent year, TITLE is used. The resulting combined variable has approximately 4,000 missing values.

b. Titles are classified according to specific key words that appear in the (modified) TITLEANN from a.. However, whenever a semicolon appears in TITLEANN, only the portion of the title that precedes the semicolon is used.

c. Titles are grouped into the following eleven categories:

Chairman and/or CEO
Vice Chairman
President
Chief Financial Officer
Chief Operating Officer
Other Chief Officer
Executive Vice President
Senior Vice President
Group Vice President
Vice President
Other

These categories correspond to categories used by Bertrand and Hallock (2001). The titles are listed in the order of perceived importance. Note that executives can hold multiple titles, but categorized titles show the highest title identified. Because the title categorization is based on an *ad hoc* process of searching for specific key words, it is necessarily imprecise. For a detailed list of key words used to identify each title, see Table A4. See Table A2 for a break down of the incidence of job titles by gender.

d. Some executives hold offices in subsidiary companies, as opposed or in addition to the parent company actually listed in the dataset. The presence of such subsidiary positions presents a serious problem for accurate title classification. We also construct an alternative variable that groups "titles" in 16 categories in order to take into account executive positions in subsidiaries. Executives who hold Chair/CEO, Vice Chair, President, or COO positions in a subsidiary company only were identified using the following method:

i. Dashes that appear to be part of title key word (e.g., V-P) were replaced with other characters.

ii. Remaining dashes were interpreted as indicators that the title includes the name of the subsidiary company. Above-mentioned titles were then reclassified as subsidiary titles, e.g., President sub.

The results of the analysis do not change when we use this alternative definition for job "titles."

e. It should be noted that there are also instances of shared positions, e.g., Co-CEOs. In all classifications the "co-" prefix is ignored and such executives are treated like full CEOs, etc. There are also instances of multiple executives within a firm and year with the same title. Again, no special treatment is given to such observations.

The results of our regression analysis do not change when we use this alternative definition of job "titles." Hence, we do not report them in the paper.

A.3 Summary statistics

Table 10: Summary statistics by sample

Full sample	Female			Male		
	Mean	Std.Dev.	N	Mean	Std.Dev.	N
Market value	9,278	23,928	1,581	8,651	26,032	43,746
Assets	18,711	92,203	1,590	15,992	67,856	43,945

Age sample	Female			Male		
	Mean	Std.Dev.	N	Mean	Std.Dev.	N
Market value	7,587	19,504	784	8,400	26,674	31,537
Assets	12,370	68,277	791	15,058	65,454	31,679
Age	47.63	6.968	791	53.69	8.437	31,685

Notes: See Table 1 for variable definitions and data sources.Market value and assets are expressed in constant, year 2000 US$.

Table 11: Number of executives by title, gender

Full sample	Number of executives	Fraction female
Chair/CEO	19016	0.014
Vice Chair	2626	0.043
President	11566	0.045
CFO	10371	0.060
COO	1963	0.035
Total	45542	0.035

Age sample	Number of executives	Fraction female
Chair/CEO	17959	0.013
Vice Chair	2041	0.038
President	6792	0.033
CFO	4557	0.049
COO	1127	0.028
Total	32476	0.024

B Additional Empirical Results

B.1 Pay-Performance Sensitivity

Table 12: Pay-performance Sensitivity. SGTot. No 2000-2001.

	Dependent variable is $\Delta SGTotal$			
	(1)	(2)	(3)	(4)
F	-94.34	-15,377	4,931	13,111
	(-0.0131)	(-0.935)	(0.666)	(0.691)
ΔV_+	23.21***	27.88***		
	(2.862)	(2.979)		
$F \times \Delta V_+$	-12.47**	-6.689		
	(-2.114)	(-0.855)		
ΔV_-	4.554	5.022		
	(0.607)	(0.542)		
$F \times \Delta V_-$	-9.424*	-16.05**		
	(-1.685)	(-2.323)		
ΔV^{ind}	-0.0974	-0.0288	0.327	0.527
	(-0.0965)	(-0.0212)	(0.329)	(0.386)
$F \times \Delta V^{ind}$	0.166	0.114	-0.346	-0.436
	(0.626)	(0.273)	(-1.076)	(-0.757)
$\%\Delta V_+$			74,606**	86,237**
			(2.240)	(2.203)
$F \times \%\Delta V_+$			-58,809**	-118,987
			(-1.960)	(-1.245)
$\%\Delta V_-$			21,948	32,286
			(0.616)	(0.736)
$F \times \%\Delta V_-$			-21,038	-16,115
			(-0.763)	(-0.225)
Title		X		X
Age		X		X
Constant	217,144	441,098	5,761	145,001
	(3.224)	(2.524)	(0.0474)	(0.630)
Observations	23,595	18,555	23,595	18,555
R^2	0.147	0.182	0.061	0.076

Notes: See Table 1 for variable definitions and data sources. All specifications control for firm and year effects, log real assets, and change in industry value. ΔV_+ and ΔV_- represent positive and negative changes in firm market value, respectively. Standard errors are clustered at the firm-year level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 13: Pay Performance Sensitivity. Positive Changes in Market Value. SG Total

	Dependent variable is $\Delta SGTotal$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
F	14,491*	5,993	11,093	-596.0	11,562*	18,195	9,871	15,509
	(7,907)	(14,535)	(7,222)	(13,996)	(6,509)	(11,393)	(6,431)	(11,636)
ΔV_+	23.01***	26.83***	23.33***	27.23***				
	(7.141)	(8.428)	(7.225)	(8.533)				
$F \times \Delta V_+$	-12.34**	-6.549	-14.52**	-7.268				
	(5.572)	(7.583)	(5.720)	(10.39)				
F^{CEO}			26,444**	32,616**			12,405**	8,398
			(10,901)	(14,028)			(5,279)	(7,646)
$F^{CEO} \times \Delta V_+$			-15.33***	-18.05***				
			(5.364)	(6.418)				
$F \times F^{CEO} \times \Delta V_+$			21.07***	14.81				
			(6.691)	(10.83)				
$\%\Delta V_+$					63,115***	75,710***	63,249***	75,794***
					(23,390)	(28,116)	(23,466)	(28,192)
$F \times \%\Delta V_+$					-56,711**	-103,408	-62,305**	-120,395
					(23,721)	(65,477)	(25,540)	(80,065)
$F^{CEO} \times \%\Delta V_+$							-35,257*	-35,319
							(21,242)	(25,930)
$F \times F^{CEO} \times \%\Delta V_+$							61,720*	112,340
							(32,149)	(79,828)
Title		X		X		X		X
Age		X		X		X		X
Constant	340,865***	601,499***	335,971***	591,523***	121,358	289,677	120,907	290,752
	(74,079)	(175,611)	(73,776)	(175,044)	(105,062)	(200,207)	(105,233)	(200,460)
Observations	28,257	22,266	28,257	22,266	28,257	22,266	28,257	22,266
R^2	0.092	0.110	0.093	0.112	0.020	0.026	0.020	0.026

Notes: See Table 1 for variable definitions and data sources. All specifications control for firm and year effects, log real assets, and change in industry value. ΔV_+ represents positive changes in firm market value. Standard errors are clustered at the firm-year level. Robust t-statistics in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

TABLE 14: Pay Performance Sensitivity. Negative Changes in Market Value. SG Total

	Dependent variable is $\Delta SGTotal$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
F	-20,854***	-27,420*	-17,132**	-16,143	-15,058**	-25,331	-14,048*	-23,325
	(7,499)	(14,507)	(6,772)	(14,096)	(7,573)	(16,713)	(7,615)	(17,479)
ΔV_{-}	22.44***	26.52***	22.80***	27.05***				
	(7.722)	(9.124)	(7.835)	(9.285)				
$F \times \Delta V_{-}$	-17.63***	-20.83***	-17.15***	-13.62**				
	(6.339)	(7.591)	(6.140)	(6.451)				
F^{CEO}			-21,683	-30,434			3,307	2,827
			(14,345)	(18,572)			(4,643)	(7,166)
$F^{CEO} \times \Delta V_{-}$			-21.48***	-26.40***				
			(7.583)	(9.065)				
$F \times F^{CEO} \times \Delta V_{-}$			16.95***	14.09**				
			(5.963)	(6.416)				
$\%\Delta V_{-}$					164,851***	204,396***	166,501***	206,245***
					(33,723)	(42,340)	(34,126)	(42,806)
$F \times \%\Delta V_{-}$					-124,988***	-174,809***	-135,611***	-210,854***
					(34,355)	(53,738)	(33,718)	(58,286)
$F^{CEO} \times \%\Delta V_{-}$							-113,085***	-135,997***
							(37,414)	(51,062)
$F \times F^{CEO} \times \%\Delta V_{-}$							133,870***	200,771***
							(45,788)	(55,840)
Title		X		X		X		X
Age		X		X		X		X
Constant	61,241	188,644	57,169	181,823	193,879**	392,746**	193,871**	392,004**
	(89,510)	(178,870)	(90,151)	(179,619)	(82,088)	(177,293)	(82,094)	(177,175)
Observations	28,257	22,266	28,257	22,266	28,257	22,266	28,257	22,266
R^2	0.055	0.067	0.056	0.068	0.017	0.022	0.017	0.022

Notes: See Table 1 for variable definitions and data sources. All specifications control for firm and year effects, log real assets, and change in industry value. ΔV_{-} represents negative changes in firm market value. Standard errors are clustered at the firm-year level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

B.2 Evidence from ATUS

Table 15: Hours spent in overall home production and with children, top 5% vs. overall population

		All	Top 5% of income							
			all	under 65						
				all	not married	married	married			
							no children	children	children	
Variable									no children under 5	children under 5
Number of observations	women	11,668	171	171	73	98	38	60	35	25
	men	9,052	496	487	93	394	104	290	168	122
Child_care_basic	women	4.0	4.1	4.1	1.4	6.1	0.0	11.4	6.7	17.8
		(9.3)	(8.2)	(8.2)	(4.5)	(9.6)	(0.0)	(10.5)	(7.8)	(10.6)
	men	1.5	2.4	2.4	0.6	2.8	0.3	4.3	3.0	6.2
		(5.5)	(6.0)	(6.0)	(2.6)	(6.5)	(2.2)	(7.6)	(7.7)	(7.2)
Child_care_teach	women	0.8	1.0	1.0	0.4	1.4	0.0	2.7	3.6	1.5
		(3.0)	(2.9)	(2.9)	(2.5)	(3.1)	(0.0)	(3.8)	(4.3)	(2.7)
	men	0.3	0.6	0.7	0.1	0.8	0.0	1.2	1.2	1.3
		(1.9)	(2.6)	(2.6)	(1.3)	(2.8)	(0.0)	(3.5)	(3.1)	(3.9)
Child_care_play	women	0.9	1.1	1.1	0.3	1.7	0.0	3.3	1.3	5.9
		(4.0)	(4.2)	(4.2)	(2.3)	(5.1)	(0.0)	(6.6)	(4.9)	(7.8)
	men	0.6	0.9	1.0	0.1	1.1	0.1	1.8	0.8	3.1
		(3.5)	(3.7)	(3.7)	(1.3)	(4.0)	(1.1)	(4.9)	(2.6)	(6.7)
Child_care_full	women	5.7	6.2	6.2	2.0	9.3	0.0	17.4	11.6	25.2
		(11.9)	(11.9)	(11.9)	(6.9)	(13.8)	(0.0)	(14.6)	(11.1)	(15.4)
	men	2.5	4.0	4.0	0.8	4.7	0.4	7.3	4.9	10.6
		(7.4)	(8.3)	(8.4)	(3.9)	(8.9)	(2.5)	(10.2)	(8.9)	(11.1)
Home_production	women	16.1	10.9	10.9	7.2	13.6	14.6	12.8	14.7	10.2
		(17.0)	(15.1)	(15.1)	(11.7)	(16.7)	(20.7)	(12.4)	(13.7)	(10.2)
	men	9.3	9.7	9.6	8.4	9.8	9.8	9.9	9.7	10.1
		(14.8)	(14.5)	(14.4)	(10.2)	(15.1)	(15.6)	(14.9)	(13.4)	(16.9)
Work_core	women	18.2	42.1	42.1	48.2	37.6	39.0	36.3	33.5	40.2
		(26.9)	(33.6)	(33.6)	(30.6)	(35.1)	(33.0)	(37.1)	(31.4)	(44.1)
	men	28.6	43.6	43.9	42.6	44.2	44.9	43.8	46.0	40.7
		(32.1)	(32.8)	(32.8)	(30.2)	(33.3)	(32.7)	(33.7)	(34.5)	(32.6)

Notes: Income is respondent's weekly earnings top-coded at $2,884.61 (approximately $150K annually). Time use information is in hours per week. *Child_care_basic* includes: physical care for household children + organization and planning for household children + looking after household children (as a primary activity) + attending household children's events +waiting for/with household children + picking up/dropping off household children +activities related to household children's health + caring for and helping household members, n.e.c. + physical care for non-household children + organization and planning for non-household children + looking after non-household children (as a primary activity) + attending nonhousehold children's events + waiting for/with nonhousehold children + picking up/dropping off nonhousehold children + caring for and helping nonhousehold children, nec + activities related to non-household children's health + caring for and helping nonhousehold member, nec + travel related to caring for and helping household children + travel related to caring for and helping nonhousehold children. *Child_care_teach* includes reading to/with household children + talking with/listening to household children + helping/teaching household children (not related to education) + activities related to household children's education+ reading to/with nonhousehold children + talking with/listening to non-household children+ helping/teaching non-household children (not related to education) + activities related to nonhousehold children's education. *Child_care_play* includes playing with children, not sports + arts and crafts with household children + playing sports with household children + playing with nonhousehold children, not sports + arts and crafts with nonhousehold children + playing sports with nonhousehold children. *Child_care_full* = child_care_basic+child_care_teach+child_care_play. *Home_production* includes meals, housework, home/car/garden/pet maintenance, household management and other necessary household related activities. *Work_core* includes working (it excludes travel related to work, job search and interviewing and other work-related activities). *Data source*: American Time Use Survey data from Aguiar and Hurst (2007) "Measuring Leisure: The Allocation of Time over Five Decades." Available at: http://www.markaguiar.com/papers/timeuse_data/datapage.html.

C Efficient Executive Compensation

In this section, we provide the details of the executive compensation model the properties are described in Section 4.1

The optimal compensation contract solves the problem:

$$\max_{\{w(\Delta V),e\},e\in[0,1]} ES\left(e\right)$$

subject to

$$e = \arg\max_{e\in[0,1]} E\left[U\left(w,e\right)\right] \tag{9}$$

$$E\left[U\left(w,e\right)\right] \geq U\left(u,0\right), \tag{10}$$

where time subscripts are dropped for ease of exposition. The objective function is the expected surplus from the shareholder-executive relationship, (9) is the executive's incentive compatibility constraint. The executive has an outside option which provides him with certain income u, and (10) is the resulting participation constraint.

The incentive compatibility constraint can be restated in the following simple form:

$$e = \arg\max_{e\in[0,1]} \tilde{w}b\left(V\right)e - \theta v\left(e\right). \tag{11}$$

Using the first order approach, we can replace (11) with the following:

$$\tilde{w}b\left(V\right) = \theta v'\left(e\right), \tag{12}$$

$$-\theta v''\left(e\right) \leq 0. \tag{13}$$

Since we assume $v\prime > 0$, (13) will automatically be satisfied.

Proposition 1 derives the optimal properties of the optimal contract.

Proposition 1 *Let $n = \{b, \sigma, \theta, u\}$ denote the vector of executive attributes and assume:*

$$v\left(e\right) = \frac{e^2}{2}. \tag{14}$$

The optimal executive compensation contract $\{e^*, \tilde{w}^*, \bar{w}^*\}\left(n, V\right)$ satisfies:

$$e^*\left(n,V\right) = \min\left\{\frac{b\left(V\right)}{\theta\left(V\right)}\frac{b\left(V\right)^2}{b\left(V\right)^2 + \sigma\theta\Sigma\left(V\right)^2}, 1\right\}. \tag{15}$$

For $e^*\left(n,V\right) < 1$:

$$\tilde{w}^*\left(n,V\right) = \left(1 + \frac{\sigma\theta\Sigma\left(V\right)^2}{b\left(V\right)^2}\right)^{-1}, \tag{16}$$

$$\bar{w}\left(n,V\right) = u + \frac{b\left(V\right)}{2}\frac{b\left(V\right)}{\theta}\left(1 + \frac{\sigma\theta\Sigma\left(V\right)^2}{b\left(V\right)^2}\right)^{-1}. \tag{17}$$

For $e^*(n,V)=1$*:*

$$\tilde{w}^*(n,V) = \frac{\theta}{b(V)}, \tag{18}$$

$$\bar{w}(n,V) = u+\frac{\theta}{2}\left(1+\frac{\sigma\theta\Sigma(V)^2}{b(V)^2}\right). \tag{19}$$

Proof. The first order necessary conditions for the contracting problem are:

$$b-\theta e-\mu\theta=0, \tag{20}$$

$$-\sigma\Sigma^2\tilde{w}+\mu b=0, \tag{21}$$

where the dependence of the parameters on V is suppressed for simplicity. Optimality requires $\tilde{w}^*=\frac{\theta e^*}{b}$ for any $e^*\in[0,1]$. For $e^*<1$, this follows from the incentive compatibility constraint.

For $e^*=1$, incentive compatibility requires $\tilde{w}^*\geq\frac{\theta}{b}$. Since any value of $\tilde{w}>\theta/b$ would not induce higher effort while generating a cost in terms of utility, $\tilde{w}^*=\frac{\theta}{b}$ for $e^*=1$. Using this and substituting (21) into (20) yields:

$$b-\theta e-\frac{\sigma\Sigma^2\theta^2}{b^2}e=0,$$

which implies (15) and(16) for $e^*<1$. The participation constraint implies:

$$u=\bar{w}-\theta\frac{e^2}{2}-\frac{\sigma^2\Sigma^2\tilde{\omega}^2}{2}.$$

It follows that for $e^*<1$:

$$\begin{aligned}\bar{w} &= u+\frac{\theta}{2}e^2\left[1+\frac{\sigma^2\Sigma^2\theta^2}{b^2}\right]\\ &= u+\frac{\theta}{2}\frac{b^2}{\theta^2}\left[1+\frac{\sigma^2\Sigma^2\theta^2}{b^2}\right]^{-1},\end{aligned}$$

which implies (17).

Conversely, for $e^*=1$, the first order necessary condition for e implies (19) and the participation constraint then implies (19). If $b-\frac{\theta}{2}\left(\frac{b^2+\theta\sigma\Sigma^2}{b^2}\right)>\frac{1}{2}\frac{b^2}{\theta}\frac{b^2}{b^2+\sigma\theta\Sigma^2}>\frac{b}{2}$, the first order necessary condition for e is satisfied and that the surplus is maximized at $e=1$. Thus, it is optimal to maximize effort. ■

Endogenous Size Distribution of Executives Let the distribution of n, the vector of executive attributes, be $\varphi_i(\cdot)$ for $i=f,m$, where f stands for female and m for male. Let N_i be the support of the distribution. Then, we can derive the population wide probability distribution density of n. Take an executive/firm pair: $\{n,V\}$ and let, Ω, denote total market capitalization.

We now derive the solution of the optical assignment problem. Let $n=\{b,\sigma,\theta,u\}$ denote the vector of executive attributes and let the distribution of n in the population of executives be $\varphi_i(\cdot)$ for $i=f,m$, where f stands for female and m for male. Let N_i be the support of the distribution. The population wide probability distribution density of n, denoted with $\varphi(\cdot)$, is defined over the support $N_f\cup N_m$. For example, if only one characteristic in n varies by gender and φ_i is a uniform and $N_i=[\underline{n}_i,\bar{n}_i]$ with $\underline{n}_m>\underline{n}_f$ and

$\bar{n}_f < \bar{n}_m$, then:

$$\Pr\left(n \leq \hat{n}\right) = \pi_f \int_{\min\left\{\hat{n},\underline{n}_f\right\}}^{\max\left\{\hat{n},\bar{n}_f\right\}} \frac{1}{\bar{n}_f - \underline{n}_f} dx + \pi_m \int_{\min\left\{\hat{n},\underline{n}_m\right\}}^{\max\left\{\hat{n},\bar{n}_m\right\}} \frac{1}{\bar{n}_m - \underline{n}_m} dx,$$

where π_i $i = f, m$ is the fraction of executives on gender i in the population.

Take an executive/firm pair $\{n, V\}$, and let Ω denote total market capitalization. The optimal firm size distribution maximizes economy wide surplus:

$$\max_{V(n)\geq 0} \int_{N_f \cup N_m} S^*\left(n, V\left(n\right)\right) \varphi\left(n\right) dn,$$

subject to

$$\Omega = \int_{N_f \cup N_m} V\left(n\right) \varphi\left(V\right) dV. \tag{22}$$

By Proposition 1, the maximized surplus from the firm-executive relationship is:

$$S^*\left(n, V\right) = \begin{cases} \frac{b(V)}{2}\frac{b(V)}{\theta}\left(1 + \frac{\sigma\theta\Sigma(V)^2}{b(V)^2}\right)^{-1} & \text{for } e^* < 1, \\ b\left(V\right) - \frac{\theta}{2}\left(1 + \frac{\sigma\theta\Sigma(V)^2}{b(V)^2}\right) & \text{for } e^* = 1. \end{cases} \tag{23}$$

We will assume that the attributes are ranked so that the top end of the support corresponds to the combination of attributes that maximizes the surplus absent any incentive problems, and denote that attribute with $\overline{n}$.

The solution to the assignment problem is characterized in the following proposition.

Proposition 2 *The optimal size distribution of executives satisfies:*

$$V\left(n\right) = \left(b\left(n\right)\right)^{-\frac{1}{(2\gamma-1)}} \left[\frac{1}{2}\frac{\int_{\underline{n}}^{\overline{n}} \left(b\left(n\right)\right)^{\frac{-1}{(2\gamma-1)}} \varphi\left(n\right) dn}{\Omega}\right]^{-1} \tag{24}$$

for $e^*(n) < 1$ *and*

$$V\left(n\right) = \begin{cases} 0 \text{ for } n < \overline{n} \\ \Omega \text{ for} n = \overline{n} \end{cases} \tag{25}$$

for $e^*(n) = 1$.

Proof. The envelope condition for the optimal contracting problem is:

$$S_V^* = \gamma \frac{S^*}{V}. \tag{26}$$

Then, the first order condition for the assignment problem is:

$$S_V^*\left(n, V\left(n\right)\right) \varphi\left(n\right) - \varphi\left(n\right) \zeta \begin{cases} \leq 0 \\ = 0 \text{ for } V\left(n\right) > 0 \end{cases} \tag{27}$$

where ζ is the multiplier on constraint (22), jointly with (22).

For $e^* < 1$, at an interior optimum, equation (27) implies:

$$\gamma \frac{S^*\left(n, V\left(n\right)\right)}{V\left(n\right)} = \zeta, \tag{28}$$

which implies:

$$V\left(n\right) = \left\{\frac{\zeta}{\gamma}\left(V\left(n\right)\right)^{-1}\right\}^{1/(2\gamma-1)}. \tag{29}$$

Rearranging (28) and integrating over $N_f \cup N_m$, substitutions obtain the solution for ζ:

$$\gamma \int_{N_f \cup N_m} S^*\left(n, V\left(n\right)\right)\varphi\left(n\right)dn = \zeta \int_{N_f \cup N_m} V\left(n\right)\varphi\left(n\right)dn,$$

$$\gamma \frac{\int S^*\left(n, V\left(n\right)\right)\varphi\left(n\right)dn}{\Omega} = \zeta,$$

$$\frac{1}{2}\frac{\int_{\underline{n}}^{\bar{n}}\left(b\left(n\right)\right)^{\frac{-1}{(2\gamma-1)}}\varphi\left(n\right)dn}{\Omega} = \left(\frac{\zeta}{\gamma}\right)^{\frac{-1}{(2\gamma-1)}}. \tag{30}$$

Combining (29) and (30) obtains (24).

For $e^* = 1$, from the first order condition (27), evaluated at $e^* = 1$, assuming an interior solution:

$$V = \left[\frac{\zeta}{\gamma b}\right]^{\frac{1}{\gamma-1}} \tag{31}$$

for $n < \overline{n}$, in order for the optimum to be interior. To solve for ζ, use equation (31) in (22), to obtain:

$$\zeta = b\gamma\Omega^{\gamma-1}.$$

Substituting this result in (31), yields: $V = \Omega$. Second order conditions then imply that $V(\overline{n}) = \Omega$, and the optimum is not interior. Hence, (25). ■