Salesforce Compensation: Revisiting and Extending the Agency-Theoretic Approach

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Abstract

Since the papers of Basu *et. al.* (1985) and Lal and Srinivasan (1993), marketing academics have been interested in the design and implementation of optimal compensation plans. The literature has focused on agency theory as a foundation to help describe and understand this process. Although there has been much theoretical work on this topic, empirical evidence to support this theory remains sparse. Studies by Coughlan and Narasimhan (1992) and John and Weitz (1988, 1989) have found some early evidence that supports agency theory.

In this paper we revisit the issue of salesforce compensation on both theoretical and empirical fronts. On the theory side we build a game theoretic model of salesforce compensation that accounts for risk aversion on the part of both the principal and the agent. We find that the results obtained from our model, while substantiating past findings, offer some new insights into the compensation design process. In particular we find that firm demographics play an important role in the design of the optimal compensation scheme. We then use two datasets collected ten years apart by the Dartnell Corporation to investigate and test hypotheses generated by our model and the extant literature. We advance the sales compensation literature methodologically by simultaneously estimating the effects of independent variables on our two compensation measures of interest: the ratio of salary to total pay, and total pay itself. We find that simultaneous estimation improves our results considerably, and is logically and theoretically motivated by the natural correlation between the dependent variables of interest. Our research thus adds to our substantive knowledge of the drivers of salesforce compensation, while adding to the theoretical structure through taking account of the possibility of principal risk aversion, and adding methodological insight through simultaneous estimation of the equations of interest.

Keywords: Salesforce Compensation, Salesforce Management, Agency Theory, Game Theory

I. Introduction

Despite the emergence of new technologies and selling formats, the importance of the salesforce as a marketing tool remains undiminished. If anything, intensifying competition and the value placed by consumers on face-to-face contact has focused even more attention on the management of salesforces. Possibly the most critical element in this process is the design and implementation of an efficient and effective salesforce compensation plan.

From the analytic foundation in Farley (1964), Weinberg (1975), and many intervening pieces of research using a certainty perspective, the mechanics of compensation design has been studied by marketers (Basu *et. al.* 1985; Lal and Srinivasan 1993; Joseph and Thevaranjan 1998) and economists alike (Holmstrom 1979; Holmstrom and Milgrom 1987) more recently from an agency theoretic perspective.[2] In the past decade or so there have also been some attempts to empirically validate the theoretical results derived in the aforementioned papers. Using data from the Dartnell Corporation, Coughlan and Narasimhan (1992) find support for many hypotheses drawn from agency theory and other economics-based theoretical research. Others looking at the issue empirically include John and Weitz (1988, 1989), Krafft, Lal and Albers (1996), and Joseph and Kalwani (1998), among others.

Our empirical investigation of the factors motivating salesforce compensation is useful in part because it revisits the Coughlan and Narasimhan (1992) research with updated data from the same source, the Dartnell Corporation. However, the work does more than simply replicate earlier results. First, we look at hypotheses unavailable in the original Coughlan/Narasimhan work, and thus expand our knowledge of the drivers of salesforce compensation. Second, we provide a longitudinal view on the drivers of salesforce compensation, letting us compare and contrast today

[2] For reviews of the salesforce compensation literature, see Coughlan and Sen (1989) and Coughlan (1993).

versus 10 years ago to see if compensation is motivated by the same factors over time. Third, we provide an analytic basis for extending the set of hypotheses available from earlier agency-theoretic approaches to salesforce compensation, as well as an empirical investigation of salesforce compensation practices. And fourth, we add a level of methodological sophistication by simultaneously estimating regressions using (a) total pay and (b) the salary-to-total-pay ratio as dependent variables, improving the efficiency of the estimators.

In what follows, we first propose an analytic model of salesforce compensation that extends the Lal and Srinivasan (1993) framework by examining the case of a risk-averse principal as well as a risk-averse agent. In particular our formulation allows us to capture the impact of firm size on the endogenous constructs. This is important because a key aspect of the data is a high degree of heterogeneity in the size of the firms. The resulting hypotheses are consistent with those derived in earlier agency-theoretic salesforce compensation models, but add some not previously available. We use this model and supporting literature sources to propose a full set of testable hypotheses concerning optimal total pay and the optimal split between salary and incentive pay in the salesforce.

After this, we describe our data and variable operationalizations. Following this, we present our estimation results and a discussion of our findings. We conclude with a summary and directions for future research.

II. Literature Review

The existing analytical literature has focused on the design of the compensation plan in the presence of moral hazard (Holmstrom 1979; Shavell 1979) arising from private information and lack of observability of salesperson effort. Basu *et. al.* (1985) discuss a two-part compensation scheme consisting of salary and a commission on sales, and provide a theoretical basis for an analysis of the impact of uncertainty, risk aversion, sales response effectiveness, marginal cost, and other parameters on the nature of the compensation scheme. Lal and Staelin (1986) extend this by presenting an analysis that relaxes the symmetric information assumption. Rao (1990) provides an alternate approach to the problem. He analyzes the issue using a self-selection framework with a heterogeneous salesforce. The salesperson picks a commission level and a quota based on her utility maximizing mechanism. While these papers do investigate optimal compensation, given a linear compensation scheme, they do not show the optimality of such a scheme in general.

In a path-breaking paper, Holmstrom and Milgrom (1987) show that, under certain assumptions, such linear compensation schemes can indeed be optimal. They do so using a dynamic framework with negative exponential utilities and an underlying Brownian motion that reflects the stochasticity of sales. Lal and Srinivasan (1993) use this framework to model salesforce compensation and gain some interesting insights into single-product and multiproduct salesforce compensation. Holmstrom and Milgrom (1991) further introduce a theory of multitasking on the part of the agent, in which agents perform a number of tasks that have different disutilities and afford them varying payoffs.

More recent analytic research aims at applying and extending the classic agency model in various directions, including competition, price delegation, multiple (substitutable or complementary) products, monitoring, and customer satisfaction measures of performance (see Bhardwaj 2001, Zhang 1994, Joseph and Thevaranjan 1998, and Hauser, Simester, and Wernerfelt 1994).

A number of empirical research studies have attempted to validate theoretical findings generated in the studies discussed above. Interestingly, a large portion of the empirical work done in the area of salesforce compensation is based on transaction cost analysis (Williamson 1975). John and Weitz (1989) and Anderson and Oliver (1987) are good examples. In another important empirical study, John and Weitz (1988) find significant discord between agency theoretic hypotheses and empirical results. In particular they find significant evidence that is contrary to agency theoretic predictions about the relation between risk, uncertainty, effort effectiveness and base sales and the salary/commission structure. Ghosh and John (2000) conduct a series of experiments to explore the insurance incentive tradeoff contained in the agency theory models. They find general support for the agency theory predictions only in the case when the agents are risk-averse and their effort is not verifiable. They conclude by stating that further work is warranted to explore why the theory's predictions do not hold when the agents are risk-neutral or when the effort exerted is verifiable.

However, other investigations have been more successful in validating agency theory results. Coughlan and Narasimhan (1992) use Dartnell Corporation survey data from 286 companies in 39 different industries and find broad support for the agency-theoretic approach. Another study by Lal, Outland and Staelin (1994) uses data from a survey of salespeople from three sales groups within a single organization. Their results also strongly support agency-theoretic hypotheses. Joseph and Kalwani (1998) study the impact of environmental uncertainty on the design of compensation plans and find strong support for the prescriptions of agency theory as well. For a good overview of the literature on incentives, please see Pendergast (1999).

The literature thus provides a broad set of analytically derived prescriptions on optimal compensation-setting, which are by and large supported in empirical studies (with the exception of John and Weitz 1988). However, some issues remain to be attacked. The issue of whether comparable results can be found over time, i.e., the robustness of the theoretical predictions, has never been investigated; we deal with this in the current paper by analyzing data from the Dartnell Corporation for 1986 and 1996, ten years apart. The theoretical literature has not treated the case of risk aversion on the part of the principal as well as the agent, typically assuming the principal to be risk-neutral – both for analytical tractability and because of a belief that it is the *difference* between risk attitudes between principal and agent, rather than the absolute levels of risk aversion, that mattered.

However, we analyze such a model in this paper, and find that the standard model's results turn out not to be robust to this change in assumptions. The resulting predictions better fit the data on compensation practices as well. Finally, some of the existing empirical literature has considered both optimal *total pay* setting and the optimal setting of the *ratio of salary to total pay*, but never in a simultaneous framework. We propose an estimation framework based on a simulated method of moments approach that accounts for the simultaneity of the two variables, the censoring issue in the ratio variable and the existence of heterogeneity across firms. In doing so our research also makes a methodological contribution.

III. Risk-Averse Principals and Scale Effects: Does Firm Size Matter in Compensation Design?

The current theory on salesforce compensation (and the executive compensation literature in economics, accounting and finance) is based on the assumptions that a risk-neutral firm employs risk-averse salespeople, and that the size of the firm has no impact on salesforce management or compensation. However, firm size clearly does vary widely, and there is little empirical evidence either that firms are risk-neutral. For example, the empirical executive compensation literature (e.g., Larner 1966; Demsetz and Lehn 1985; Jensen and Murphy 1990; Hall and Liebman 1998) shows that firm size tends to impact the correlation between pay and performance. Compensation practice thus does vary with firm size. At the same time, this literature also argues that larger firms tend to have a larger scale of operations that could possibly lead to higher variance in their outputs, which is not relevant for compensation policy under an assumption of firm risk neutrality, but become important if firms are not purely risk-neutral. Further complicating this issue is that larger firms might be more efficient; this in turn might lead to higher levels of productivity and effort on the part of their employees. While these arguments describe a complex process, they point towards the importance of understanding the interaction and impact of firm size and firm risk attitude on compensation policy.

The key issue, of course, is not *whether* firm size matters but *how* it matters. As mentioned earlier, the compensation literature assumes that firms are risk neutral. The argument behind this assumption is that larger firms have shareholders who can hold diversified portfolios and can therefore spread their risk across negatively correlated signals. While this argument may hold for a handful of large publicly held firms, it does not hold for the vast majority of small businesses (for example, the risk aversion of a sole proprietorship is equal to that of its owner). In other words, if we place firms on a size-continuum, we should expect smaller firms to be more risk averse. We therefore assume that the firm is risk averse and model its risk aversion parameter as a negative function of firm size.

Note that the case of a risk-neutral firm and a risk-averse salesperson is the basis for the prior analytic literature on agency theory. The case of risk neutrality of both the firm and the salesperson is already analyzed by assuming that the sales response function is deterministic and that the effort of the salesperson is observable. The case of a risk-averse firm and a risk-neutral salesperson is not an interesting one, because in this case, the firm's optimal behavior is to "sell the firm" to the salesperson, who will bear residual risk in the firm without being overly conservative. However, the case of risk aversion on the part of both the firm and the salesperson has not been considered in the salesforce literature. By relaxing this assumption, we are thus also contributing to the agency theoretic literature on salesforce compensation.

Firm size has an equally important effect on sales response. Larger firms will not only have better reputations, stronger brands, and more efficient systems, but they will also operate on a larger scale. A salesperson working for a larger firm may be able to sell a broader range of products, or may be able to gain access to potential customers more easily, than the salesperson working for a smaller firm. On the other hand, larger firms may also face greater variability in sales. We term this cumulative effect the "Scale Factor" effect, and model it by allowing firm size to positively affect the sales response function.

Based on the above discussion, we posit an agency-theoretic model of salesforce compensation in which not only the salesperson, but also her employer firm, is risk averse. The framework also explicitly allows for firm size to affect both the firm's risk aversion and its scale of operations. We account for the scale effect by assuming that the sales response function is multiplied by a scale factor, $g(s)>0$, where s denotes the size of the firm, and where $g'(s)>0$. We further account for the firm's risk aversion through a constant absolute risk aversion (CARA) formulation with functional form $R(s)>0$. Specifically, we assume that $R(s) = r/g(s)$, where r is the firm risk aversion parameter. This assumption is intuitive in that it implies that the firm's risk aversion decreases in the scale of its operations $R'(s)<0$.

We use a linear effort response function with normal errors as is standard in the literature (see Holmstrom and Milgrom 1987 and Lal and Srinivasan 1993). Thus we can represent sales (x) as

(1) $$x = g(s)\left(h + ke + e\right) \quad with\ \ e \sim N(0, s^2)$$

where e is the salesperson's effort level, h>0 is the base level of sales (in the absence of salesforce effort), k>0 is the marginal productivity of sales effort, and e is the normally distributed error term in the sales response function. This directly implies that

(2) $$x \sim N\left(g(s)\left(h + ke\right), g(s)^2 s^2\right)$$

We now describe the salesperson's optimization program. The sales agent is assumed to be risk averse with constant absolute risk aversion parameter $r>0$. The salesperson's utility function can then be characterized as

(3) $$U_S = K - \exp(-rW).$$

W in (3) represents net wealth, and *K* is a positive parameter. This net wealth can be simply described as *Total Pay – Cost of Effort*. Holmstrom and Milgrom (1987) show that the linear compensation contract is optimal for this problem. Therefore, $W = a + b \cdot x - c(e)$, where a is the salary paid by the firm to the salesperson and b is the commission rate. *c(e)* denotes the disutility to the salesperson of exerting effort level *e*, and is captured by the formulation

(4) $$c(e) = \frac{d}{2}e^2, \text{ where } d > 0 .$$

Substituting into the salesperson's utility function and taking expectations, we arrive at the expected utility function:

(5) $$E(U_S) = \int_{-\infty}^{\infty} [K - \exp(-r\{a + bx - c(e)\})] f(x) dx$$

Recognizing the relation between (5) and the moment generating function of the normal distribution, we can rewrite (5) as

(6) $$E(U_S) = K - \exp\left(-r\left\{a + b\, E(x) - c(e) - \frac{r}{2} b^2 Var(x)\right\}\right).$$

Maximizing (6) is equivalent to maximizing the term inside the curly brackets. This is known as the certainty equivalent. The salesperson then maximizes her certainty equivalent, SCE, which can be described as

(7) $$SCE = a + b[g(s)(h + ke)] - \frac{d}{2}e^2 - \frac{r}{2} b^2 g(s)^2 s^2$$

The salesperson maximizes this expression with respect to *e*, which gives us the following incentive compatibility (IC) condition defining the level of effort the salesperson will exert:

(IC) $$b\, g(s)k - de = 0 \iff e = \frac{b\, g(s)k}{d} .$$

In addition to the incentive constraint, the firm also has to ensure that the salesperson makes at least her reservation utility. This can be reflected through the Individual Rationality (IR) constraint, described by:

(IR) $SCE \geq W_o$,

where W is the minimum certainty equivalent of the salesperson (or equivalently, her opportunity cost of time). The (IC) and (IR) constraints are both taken into account by the firm in its own profit maximization problem.

The firm is assumed to be a risk-averse profit-maximizing entity, also characterized by a CARA utility function. In particular, we assume that the firm's risk aversion is captured by the function *R(s)*. We also assume that the firm faces a constant marginal cost, and without loss of generality we set that marginal cost equal to zero. One can then interpret sales as being represented in dollar terms. Following a similar logic as in the salesperson's case, the firm's certainty equivalent can then be denoted by

(8) $$FCE = (1-b)\left[g(s)(h+ke)\right] - a - \frac{R(s)}{2}(1-b)^2 g(s)^2 s^2 \ .$$

The firm maximizes FCE subject to the constraints imposed by the contracting scenario. In the first best case, this involves only the individual rationality (IR) constraint, while in the second best case, both the individual rationality (IR) and incentive compatibility (IC) constraints need to be satisfied. The solutions and their interpretation are discussed in detail below.

The First Best Solution

In the first best solution, the firm has the ability to observe and hence induce any desired level of effort by the salesperson. In previous research, such a scenario is usually shown to result in a forcing contract. However, this result does not immediately follow when the principal is risk averse.

In the first best world the firm's problem is to maximize FCE over *e* and b. However the firm does have to meet the (IR) constraint. We assume that the (IR) constraint is binding, implying that $a = W_0 + c(e) + \frac{r}{2} b^2 g(s)^2 s^2 - b[g(s)(h + k e)]$. Now substituting a into FCE and simplifying, we obtain the total certainty equivalent:

(9) $$TCE = g(s)(h + k e) - \frac{d}{2} e^2 - \left(\frac{r}{2}\right) g(s)^2 b^2 s^2 - \left(\frac{R(s)}{2}\right) g(s)^2 (1 - b)^2 s^2 - W_0 .$$

Maximizing this with respect to b and *e* yields:

(10) $$b^* = \frac{R(s)}{R(s) + r} = \frac{r}{r + r\, g(s)} \;;\quad e^* = \frac{k\, g(s)}{d} .$$

This pair reflects the Pareto-optimal risk sharing arrangement between the firm and the salesperson. The value of b^* also represents the lower bound on the commission rate. Any sharing rule with a b below this would not be acceptable to the salesperson (it would violate the (IR) constraint). Notice that sales response function uncertainty (via s) does not play a role, since effort is perfectly observable. The sharing rule (β^*) and effort have one common element, viz., firm size. Also notice that b^* is zero for r*=0* (a risk-neutral firm), while for any r*>0* (a risk-averse firm), the optimal compensation contract *must* include commissions. Further, $\frac{\partial b^*}{\partial r} > 0$, and b^*®1 as r ® ¥.

This is in contrast to the risk-neutral case, where many contracts (including the forcing contract) are possible.[3]

The Second Best Solution

While the first best case describes an ideal scenario, in reality the effort of the salesperson is not perfectly observable and hence not contractible. In the second best world, the firm therefore

[3] The forcing contract is in fact a special case of our model, obtained by setting r=0.

cannot induce the salesperson to put in the first best effort. This leads to a moral hazard problem (since the salesperson now has an incentive to shirk) that causes the firm to take account of the incentive compatibility constraint (IC). Substituting this constraint (implicitly defined by $e=\frac{b\,k\,g(s)}{d}$) into the maximization problem depicted in (9), we have

$$TCE = g(s)\left(h+\frac{g(s)b\,k^2}{d}\right)-\frac{g(s)^2\,b^2\,k^2}{2d} \tag{11}$$
$$-\left(\frac{r}{2}\right)g(s)^2\,b^2\,s^2-\left(\frac{R(s)}{2}\right)g(s)^2\,(1-b)^2\,s^2-W_0$$

This problem is similar to the Lal and Srinivasan (1993) problem except for the penultimate term, which arises due to the relaxation of the assumption regarding the principal's risk neutrality. Maximization of *TCE* with respect to b gives us

$$b^* = \left[\frac{k^2+dR(s)s^2}{k^2+\left(d\left(r+R(s)\right)s^2\right)}\right]=\left[\frac{g(s)k^2+d\,r\,s^2}{g(s)k^2+\left(d\left(g(s)r+r\right)s^2\right)}\right] \text{ and } e^*=\frac{b^*kg(s)}{d} \tag{12}$$

Note that when the firm can observe the salesperson's effort (in the first-best solution, given by (10)), the salesperson exerts more effort and the commission rate is lower than when the firm cannot observe the salesperson's effort (in the second-best solution, given by (12)). Also note that when ρ=0, we obtain the same results as Lal and Srinivasan (1993). We can use the fact that $SCE=W_o$ to obtain the optimal a, which is now described as

$$a^* = W_0 + \frac{d}{2}\left(e^*\right)^2+\frac{r}{2}g(s)^2\left(b^*\right)^2 s^2 - b^*\,g(s)\left(h+k\,e^*\right).$$

Total expected pay is $T^* = a^* + b^*\,g(s)\left(h+k\,e^*\right)$, which can be simplified to

$$T^* = W_o+\frac{d}{2}e^{*2}+\frac{r}{2}g(s)^2\,b^{*2}s^2. \tag{13}$$

This equation highlights the fact that the salesperson's total income is a sum of the opportunity cost of his time (W_0), the cost of his effort ($\frac{d}{2}e^{*2}$), and the risk premium ($\frac{r}{2}g(s)^2\, b^{*2}\, s^{\ 2}$). We can also compute the ratio of salary to total pay as

(14) $$p^* = \frac{a^*}{a^* + b^* g(s)\,(h + ke^*)}.$$

This ratio has widely been used as a dependent measure in a number of empirical studies (see Coughlan and Narasimhan 1992; Lal, Outland and Staelin 1994).

Before proceeding further, we first analyze some of the comparative statics that emerge from our solution. In particular, we are interested in the effects of various parameters on Total Pay (T^*) and the ratio of salary to total pay (p^*), since these are the dependent variables used in our empirical analysis. Table 1 describes the comparative statics of T^* *and* p^* with respect to the exogenous variables in the model. Appendix A presents the detailed derivation of the comparative static effects. While most of our comparative statics are consistent with those found in earlier literature (e.g. Lal and Srinivasan 1993), some are not. Since the comparative statics with respect to salesperson risk aversion, opportunity cost and the base level of sales are the same as found in the extant literature, we do not discuss them here.[4] However, Table 1 does offer some new insights.

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[4] The reader is referred to Basu et. al. (1985), Lal and Srinivasan (1993), and Lal and Staelin (1986) for more details on these comparative statics.

Table 1 : Comparative Statics

	Salary/ Total-Pay (p^*)[(a)]	**Total Pay (T^*)**
Firm Size (s)	-[(b)]	+
Firm Risk Aversion (r)	-	+
Salesperson Risk aversion (r)	+	-[(c)]
Variance (s^2)	+	~[(d)]
Opportunity Cost (W_o)	+	+
Base level of Sales (h)	-	**0**
Marginal Productivity (k)	-	+
Cost of Effort (d)	+	-

(a) The sign in the cell indicates the change in the column variable with respect to the row variable.
(b) The sign holds under reasonable restrictions on the parameter space. See Appendix A for details.
(c) The sign holds under reasonable restrictions on the parameter space. See Appendix A for details.
(d) This derivative is negative for low values of the firm's risk aversion, but positive when the firm is very risk-averse. See Appendix A for details.

First, we predict that firm size has a positive effect on total pay, and a negative effect on the ratio of salary to total pay. In our model, firm size has two effects: larger firms have larger sales per salesperson (because our sales response function is modeled as $x = g(s)(h + ke + e)$), and larger firms are less risk averse than smaller firms. Note from (1) that firm size affects the salesperson's marginal productivity of effort. Therefore, the salesperson puts in a higher level of effort and, to compensate for this effort, total pay must increase. Because even baseline sales are larger at larger firms, a large firm also optimally gives the salesperson a more incentive-heavy pay plan than that offered by a smaller firm.

Second, the inclusion of the firm's risk aversion and scale effects allow us to investigate how they affect optimal compensation in the model. It is not surprising that an increase in the firm's risk aversion parameter, r, tends to increase the predicted commission rate (see equation (12)). Consequently, this also results in an increase in the optimal level of effort and ultimately in the total compensation paid to the salesperson. Further, a more risk-averse firm pays a lower salary than a less risk-averse firm does. Thus, more risk-averse firms rely proportionately more heavily on incentives. Another important effect of modeling the firm as a risk-averse entity is that although the signs of many of the comparative statics (e.g. salesperson risk aversion) are the same as those in earlier work, the magnitude of their impact is now moderated by the firm's risk aversion parameter.

The third new result pertains to the effect of uncertainty (s^2) on total pay. Note that we can write total pay as the sum of the reservation utility, cost of effort and the risk premium. That is:

$$T^* = W_o + \frac{d}{2} e^{*2} + \frac{r}{2} g(s)^2 b^{*2} s^2$$

From equation (12), we can see that both b^* and e^* are decreasing in s^2. If r=0, then it can be shown that T^* is also decreasing in s^2 (See Lal and Srinivasan 1993). However, if r is sufficiently large, total pay is increasing in s^2.[5] In economic terms, this implies that if the principal is sufficiently risk averse, an increase in uncertainty leads to *higher* total pay due to an increase in the risk premium caused by the incremental uncertainty.

The fourth result of note concerns the impact of marginal productivity (*k*) and the cost of effort (*d*) on the ratio of salary to total pay (p). Like Lal and Srinivasan (1993), we find that these two effects cannot be signed unconditionally. Lal and Srinivasan show that for a high base level of sales (i.e. *h* large enough) the effects can be determined (i.e. $\frac{\partial p}{\partial k} < 0, \frac{\partial p}{\partial d} > 0$). In our more comprehensive modeling structure, assuming a large *h* alone is not sufficient to guarantee the signs of these effects, but under most reasonable parameter values, we also find that the ratio of salary to total pay falls with *k* and rises with *d*.

The new insights presented above help us gain additional insights into the drivers of salesforce compensation. While affirming the standard agency theoretic literature findings, we have also underlined the complexity of the interactions between these variables. In some cases it might indeed be difficult to isolate the effect of the variables in question. Clearly, however, the size and risk attitude of the firm cannot be trivially assumed away.

IV. Data and Variable Operationalizations

To test the implications of the theoretical model, we need to operationalize the key constructs. We now describe our dataset and the operationalization of our measures.

The data come from the Dartnell Corporation's 1996-1998 salesforce compensation survey (published in 1998). This is an annual survey of salesforce managers, querying them about their compensation practices and the characteristics of their salespeople. The earlier Coughlan and Narasimhan (1992) paper used Dartnell's 1986 data. Thus, this investigation provides an intriguing opportunity to investigate the dynamic robustness of salesforce compensation practices across time in a comparable set of respondents.

However, the content and list of questions in the 1998 survey do differ from those in the 1986 survey. First, entire sections on Quotas and Payment Horizon[6] have been dropped. In our discussions with Dartnell, no particular reason was given for this change; the deletion was evidently purely based on the questionnaire's length constraints. While these differences make a fuller comparison between our analysis and that in Coughlan and Narasimhan (1992) impossible, they are only tangentially related to the key constructs used in this study and in our opinion do not radically change the nature of results. Our analysis therefore uses both datasets (1986 and 1996) to estimate our new models and thus facilitates a clear understanding of the dynamic changes in U.S. salesforce

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[5] Specifically, for $r > \left(\frac{g[s]}{2ds^2}\right)\left(\sqrt{8k^4 + 8dk^2rs^2 + d^2r^2(s^2)^2} - 2k^2 - drs^2\right)$, total pay rises with σ^2. See Appendix A for details of the derivation.

compensation practices. Beyond this, the dataset permits us to test additional hypotheses not tested in the earlier work, especially the effects of firm size.

Data Description and Discussion

Table 1 provides descriptive statistics of the key variables used in our analysis. We find that while total pay has increased, the ratio of salary to total pay has marginally declined over the ten years between the surveys used.[7] There seems to be a move towards a greater proportion of incentive based pay in the total pay plan. One explanation for this would be the emergence of newer and cheaper technology that has affected numerous facets of salesforce management. For example, salesforce automation software has allowed firms to better track and monitor effort, while the widespread use of the Internet and other electronic communication has increased productivity and lowered training costs. This is seen in the decline in the training cost measure in Table 1. Training length has increased, as has the average tenure of a salesperson. Added to these is the fact the average number of calls that it takes to close a sale has also been declining. Given these changes, it is not surprising that the 1990s are marked by a shift towards increased incentives. In the next few paragraphs we discuss the variables used in our empirical analysis in more detail.

Table 2 reports the distribution of firm sizes in the 1986 and 1996 samples. The more recent sample contains a greater proportion of larger firms, but is not extremely different in the range of firm sizes represented.

Table 3 presents summary statistics for the different experience levels of salespeople in the firms surveyed in 1986 and 1996. The U.S. Consumer Price Index (CPI) rose 43.2 percent over the 1986-1996 period,[8] while average total pay in the Dartnell samples rose by 51.6 percent, 46.5 percent, and 49.0 percent for experienced, semi-experienced, and trainee salespeople, respectively;

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[6] For details of the 1986 survey and data, please see Coughlan and Narasimhan (1992).

[7] While the table presents dollar figures as reported, we also examined the effects of adjusting them by the CPI to be comparable. All our results and discussions hold for the CPI adjusted measures as well.

thus, salesforce pay increases overall beat the inflation rate by several percentage points over this time period. Concurrently with the increase in total pay, all three classes of salespeople received a lower proportion of total pay in salary in 1996 than in 1986.

The dependent variables we use in our analysis are *Total Pay* and the *Ratio of Salary to Total Pay*. The ratio of salary to total pay has been used in previous studies (Coughlan and Narasimhan 1992; Lal, Outland and Staelin 1994; John and Weitz 1989) as a measure of the relative importance of incentives in the compensation plan.

We use several independent variables in our analysis that relate to the agency theory constructs used in our model. The relation between our variables and these constructs is summarized in Table 4. For the sake of brevity we do not repeat the details of the table in the text. Note, however, that a certain set of variables indicated by an asterisk in Table 4 are the same as used by Coughlan and Narasimhan (1992). The set of variables we use give us indirect evidence suggestive of the role of firm-level risk aversion in setting compensation.

One key variable that impacts the structure and nature of the sales compensation contract is *Firm Size*. An implicit assumption made in most empirical studies is that firms are similar in terms of the scale of operations. However, this is often not the case, as Table 2 shows. This distribution of firms lends some credible justification for the framework used in the theoretical analysis.

We measure size of the firm by its dollar sales volume, which Dartnell's survey publishes as a categorical variable (as in Table 3). Based on our theory, we predict that larger firms will offer higher total pay as well as a lower ratio of salary to total pay.

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[8] For a time series of the United States CPI, see http://www.bls.gov/cpi/home.htm .

V. Estimation Issues

The Methodology

The dependent variable π (proportion of salary to total pay) is bounded between zero and one by virtue of being a proportion. Hence standard least square methods will yield biased estimates. To correct for this we use the Double Limit Tobit proposed by Coughlan and Narasimhan (1992). This approach assumes that the data is censored at both tails (specifically at 0 and 1). Since by definition π cannot exceed one or fall below zero it seems appropriate to consider the data censored. Since there are no structural bounds on the nature of the Total Pay variable we can use ordinary least squares (OLS) to estimate the relevant effects.[9]

Since our theory suggests that the effect of size on compensation is complicated, we allow the size effect to vary across firms by allowing a normal mixing distribution to be placed on the parameter that measures the impact of size on compensation.[10] In addition, we also include a random effect on the intercept to account for other sources of potential heterogeneity. One last econometric issue that we feel needs addressing is the simultaneity that exists between total pay and the ratio of salary to total pay. The earlier empirical work in this area (such as Coughlan and Narasimhan 1992 and Outland, Lal and Staelin 1994) ignores this issue. By the very definition and structure of the constructs and timing of the decision, there must exist a correlation between the two regression errors. We adopt a GMM procedure which accounts for this correlation, described in Appendix B. To summarize, our estimation framework:

a) allows for simultaneity of the two dependent variables;

b) accounts for the double limit tobit nature of the salary to total pay variable;

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[9] Please see Figures 1 and 2 in Appendix B for a depiction of the distribution of the two dependent variables across the firms in the data.

[10] As an alternative, we tested various functional forms for the specification of firm size, and found no qualitative differences in the results. Further details of the estimation procedure are included in Appendix B.

c) and allows for heterogeneity in the Intercept and Firm Size effects.

VI. Empirical Results and Discussion

Our empirical analysis finds strong support for the tenets of agency theory in general and our theoretical model in particular. Most of the variables exhibit significant effects and are generally in the direction we expect. Moreover, our approach to modeling the two aspects of compensation (Total Pay and Salary/Total Ratio) jointly results in increased levels of efficiency.[11] This improved efficiency is a direct result of accounting for the inter-equation correlation, which is negative and significant in both datasets. Any unobserved variable that affects the total pay equation positively (negatively) would imply that the salary/total pay disturbance would be negative (positive) in general. While it is theoretically possible for the errors to be positively correlated, we suspect that in general the correlation is likely to be negative.

Temporal Shifts in Compensation Design

Our data offer a unique opportunity to test whether compensation practices evolve over time due to changes in economic conditions and firm characteristics. To ascertain, at a global level, whether there were any differences between the 1986 and 1996 data we conducted a pooling test based on difference of Hansen's *J*–statistics (Hansen 1982; Ogaki 1993.) The combined *J*-statistics for the two datasets was 2720.42 while the pooled data model obtained a *J*-statistic of 2740.91. The difference of the two statistics is 20.49 and is asymptotically distributed as χ^2 with one degree of freedom. We therefore conclude that pooling is rejected at less than the 0.0001 level. This finding is significant, as it implies that the dynamics of the 1986 and 1996 data are different. In particular it

[11] While details are not reported here because of space concerns, we find that estimating the regressions separately results in significantly higher GMM objective functions and standard errors.

implies that the effects of the variables included in our model on compensation are different in the 1986 and 1996 datasets.

Comparing the results in Tables 5a and 5b, we uncover some noteworthy shifts in compensation design over time. For example, the compensation differences between experienced and less experienced salespeople are less pronounced in 1996 than in 1986. While a senior sales rep still receives approximately $15,500 more in total pay than a new sales rep in 1996, the structure of compensation for all reps is more incentive-driven than in 1986. Furthermore, the ratio of salary to total pay of a senior rep is only 7% lower than that of a new rep in 1996, compared to about 10% in 1986. We conjecture that improvements in monitoring technology, process improvements and salesforce automation have reduced the distortion caused by moral hazard and have resulted in the dynamics described above.

The Impact of Firm Size

Some key findings in our results pertain to firm size. First, we find that firm size is a critical determinant of both compensation level and structure. This is evidenced by the fact that the mean effect of firm size is significant (albeit marginally so for the salary/total ratio in 1986) in all models and its coefficient signs are essentially consistent with our theoretical predictions. Specifically, the mean coefficient for firm size is negative in the salary to total pay regression, and larger firms tend to pay more in total, both as per our theory. Second, we observe significant heterogeneity across firms in the way firm size impacts compensation. All effects of firm size also exhibit significant variances which are fairly large. This leads us to conclude that while the results are broadly consistent with theory, these might exist some firms for whom the effect of firm size is contrary to our expectations. Indeed some computations of the posterior marginal effect of firm size revealed that a small number of firms had marginal effects of size that were contrary to our theoretical prediction. We conjecture that this reversal could be due to the fact that technical assumptions made by us on the parameter space[12] do not reflect the conditions faced by these firms. Generally speaking, these findings do, however, underline the need for including firm size and other factors relating to scale and firm risk aversion in theoretical and empirical models of salesforce compensation.

The Effect of Other Variables

As mentioned earlier, most of the coefficient signs are consistent with our theoretical predictions. The variables positively correlated with our theoretical construct of marginal productivity include *Senior Dummy, Intermediate Dummy and Training Length*. We expected each of these to have a positive effect on total pay and a negative effect of the salary to total pay ratio. The results in Tables 5a and 5b show that our expectations are met and the effects are significant. Interestingly, although our descriptive statistics show an increase in overall pay levels from 1986 to 1996, they clearly show that the *incremental* premia in total pay due to seniority have not increased, either for intermediate or senior salespeople; a compression effect in pay is evident. Further, the coefficients are smaller in absolute value in the 1996 salary-to-total-pay regression than in the 1986 one. This is consistent with the notion that firms are moving towards more incentive-heavy pay packages, because of better monitoring abilities. Since better monitoring reduces uncertainty in the effort-sales relationship, it leads to increased reliance on incentive pay.

The effect of the outside option on compensation is measured by *Service* and *Turnover*. The longer the experience of the salesforce and the higher the turnover from the firm, the higher are the opportunity costs for a salesperson. Correspondingly, one should see a higher salary component and a higher level of total pay for increases in these two variables. The effect of service is positive and significant in the salary-to-total-pay regressions, as predicted: the more experienced is the firm's salesforce overall, the higher its salespeople's opportunity cost of time is likely to be, and hence the more certain their pay should be. Service also has a marginally significant positive effect on total pay

[12] See note (b) in Table 1. For details see Technical Appendix.

in the 1996 data, again consistent with the theoretical predictions, but has an insignificant effect on total pay in the 1986 data. The weaker total pay effect could be due to the notion in agency theory that a more certain (more salary-heavy) pay package for a risk-averse salesperson need not be as large as a more leveraged one, because its certainty equivalent value is higher, *ceteris paribus*.

We note that the effect of turnover is insignificant in all of our regressions. There are two possible explanations for this result. On the one hand, it might suggest that the turnover variable is an imperfect proxy for the opportunity cost of a salesperson, leading to our weak results. The other, more plausible, explanation is that our measure of turnover is a very coarse measure and consequently, variation in it does not capture the cross-sectional variation in our dependent variables. Specifically, the Dartnell turnover measure is a short-run measure (of the amount of turnover this year versus last year in the firm), which may not have strong implications for the overall pay structure.

One variable that goes against our theoretical predictions is the calls to close variable, a proxy for the uncertainty of sales. Under this proxy definition, we expect a higher salary to total pay ratio and also higher levels of total pay in firms with a greater average number of sales calls necessary to close a sale. However, apart from the 1986 total pay regression, where the coefficient is not significant (although weakly in the expected direction), all other effects are contrary to our hypothesized direction. One explanation for these results is the possibility that calls to close partially measures the salesforce's marginal productivity. Clearly, a selling job that requires more sales calls to close the sale provides more opportunities to *lose* the sale, and hence increases the uncertainty in the selling process, all other things equal. Our results suggest that firms' response to this reality may simply be to focus their more experienced salespeople on the more uncertain accounts, or indeed to hire an overall more experienced salesforce. Theory suggests that the optimal pay plan would promise a higher total pay level, but rely more heavily on incentives, as we find in our results.

The control variables used in our analysis include two factors relating to marketing expenditures by the firms and a dummy representing whether the firm was involved with industrial products, services and/or customers. We found that in general, an increase in supporting marketing expenditures results in higher total pay and higher salary-to-total-pay ratios. These might reflect deliberate actions on the firm's part to trade off incentives with other sales supporting activities such as promotions, expense budgets and technology that also support sales. The coefficient of the *Industrial* dummy in the 1996 data is generally in the same direction as those coefficients positively related to marginal productivity. Many firms dealing in industrial products and services require more capable salespeople, and this appears to lead to higher and more incentive-driven compensation packages.

To summarize, the results of our empirical exercise provide strong support for our theoretical model. The results are generally robust from 1986 to 1996, although some predictors are more significant in the 1996 regressions. Firm size, in particular, is shown to be a significant predictor of pay patterns, even in the presence of the other factors considered in prior research. Heterogeneity among firms in their size as well as unobserved factors play strong roles in the compensation structure.

VII. Summary and Directions for Future Research

This paper makes theoretical, methodological, and substantive empirical contributions to the Marketing literature on salesforce compensation. On the theoretical front, we extend the theory presented in Lal and Srinivasan's (1993) approach to include the possibility of a risk-averse principal (Lal and Srinivasan assume that the principal is risk-neutral while its agent is risk-averse). On the methodological front, we introduce a simultaneous estimation procedure to the empirical work.

Simultaneous estimation of the total pay and salary/total pay regressions improves the efficiency of the estimation. We are also able to compare the influence of important constructs on incentive pay and total pay across two time periods. We find that while the influences of some of the drivers change across time, the directional impacts across the two time periods are robust.

On the substantive empirical front, our results demonstrate the robustness of the general agency theoretic approach to predicting salesforce compensation practices. All of the hypotheses supported in Coughlan and Narasimhan (1992) continue to hold in the newer data, suggesting that companies find these rules for setting compensation to be broadly applicable across time. However, our results also indicate the value of including firm size in the estimation, as postulated in our analytical extension. As predicted, larger firms pay more than smaller firms, and allocate a larger fraction of pay to incentives.

Future research in the salesforce compensation area can take various directions. Dual distribution and team selling, where both an employee salesperson and an independent agent join together to make the sales effort, is an interesting and underresearched area. The effect of competition among manufacturers on optimal salesforce compensation is also important to investigate. Considering salesforce effort along with other marketing mix efforts such as promotion could further improve salesforce compensation-setting. These are just a few of the interesting topics that future research (both on the analytic and empirical fronts) can focus on to shed further light on salesforce compensation practices.

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Table 1: Summary Statistics		1996		1986	
		Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
Total Pay (thousand dollars)		50.07	25.08	33.69	15.21
Salary/Total Pay (proportion)		0.61	0.33	0.63	0.35
Volume (hundred thousand $)		3.47	6.42	1.07	2.08
Calls to Close (number)		5.67	10.18	5.93	7.45
Service (years)		7.29	4.91	6.20	5.47
Training Length (months)		4.64	4.56	4.20	4.92
Turnover (%)	*Low*	16.2%		54.2%	
	Usual	58.6%		14.8%	
	High	25.2%		31.0%	
Industrial Products or Consumers	(1/0)	72%		55%	
Firms		**404**		**286**	

Table 2: Distribution of Firm Size in Sample*

		1996		1986	
Gross Revenues ($ million)	**Size**	**Number of Firms**	**Percent**	**Number of Firms**	**Percent**
<5	0	95	23.5%	102	35.7%
5-25	1	125	30.9%	110	38.5%
25-50	2	48	11.9%	29	10.1%
50-100	3	29	7.2%	19	6.6%
100-250	4	30	7.4%	11	3.8%
250-500	5	15	3.7%	3	1.0%
500-1000	6	30	7.4%	8	2.8%
1000-2000	7	12	3.0%	2	0.7%
2000-5000	8	9	2.2%	2	0.7%
>5000	9	11	2.7%	0	0.0%
		404		**286**	

Table 3: Summary of Pay Statistics by Seniority

	1996		1986	
	Total Pay ($000)	**Salary/Total Pay**	**Total Pay ($000)**	**Salary/Total Pay**
Experienced (mean)	63.34	0.567	41.78	0.585
(std. dev.)	(30.88)	(0.33)	(16.91)	(0.36)
	47.62	0.598	32.51	0.621
Semi-Experienced	(22.07)	(0.32)	(11.20)	(0.34)
	35.66	0.661	23.93	0.701
Trainee	(12.34)	(0.33)	(9.54)	(0.36)
	50.07	0.605	33.69	0.630
Average	(25.08)	(0.33)	(15.21)	(0.35)

Table 4: Variable Descriptions

Dependent Variables		Description
Salary/Total Pay*		Ratio of salary pay to total pay. Equals one for all salary salesforces and zero for all commission salesforces. Reported by level of seniority.
Total Pay*		Total Compensation paid to salesperson in thousands of dollars. Reported by level of seniority.

Variable		Description		Theory Construct		Expected Sign: Salary/ Total Pay	Expected Sign: Total Pay
Size		The size of the firm. Reported as a categorical variable from one through 10. The first category represents company wide sales of $5 million while category ten reflects sales of $5 billion.		*Firm Size*		-	+
Calls to Close*		The average number of calls it takes a salesperson to close a sale		*Uncertainty*		+	-
Service*		The Average length of service of a salesperson in years.		*Opportunity Cost*		+	+
Training Length*		The average length of training (in months) a new salesperson goes through before entering the active salesforce.		*Marginal Productivity*		-	+
Turnover*		Indicator of relative turnover in the firm. Measured as a three point scale indicating turnover was lower, same as or higher than usual in the past two years.		*Opportunity Cost*		+	+
Senior*		Indicator for Experienced Salesperson. A binary variable with one indicating that the salesperson has significant sales experience and the ability to handle important territories and/or key accounts independently.		*Marginal Productivity*		-	+
Intermediate*		Indicator for a semiexperienced salesperson. A binary variable with one indicating that the salesperson has enough sales experience and the ability to handle a territory independently.		*Marginal Productivity*		-	+
Factor 1*		Factor 1 (factor score) derived from a factor analysis of expenses incurred by firms on lodging/travel/marketing expenses.		*Control Variable*			
Factor 2*		Factor 2 (factor score) derived from a factor analysis of expenses incurred by firms on lodging/travel/marketing expenses.		*Control Variable*			
Industrial Dummy		Dummy Variable equal to one if the firm deals in industrial products or sells to industrial consumers		*Control Variable*			

* Variable was used by Coughlan and Narasimhan (1992).

Table 5a

1986 Data

Salary to total Pay

Variable	Estimate	Std. Err.	T-Stat	P-Value
Intercept (mean)	0.6353	0.0397	16.01	<.0001
Intercept (std.dev)	0.3248	0.0145	22.33	<.0001
Size (mean)	-0.0165	0.0094	-1.76	0.0791
Size (std.dev)	0.0709	0.0053	13.31	<.0001
Calls to Close	-0.0037	0.0014	-2.59	0.0101
Training Length	-0.0075	0.0025	-2.96	0.0033
Service	0.0079	0.0023	3.50	0.0005
Turnover	-0.0033	0.0125	-0.26	0.7949
Senior Dummy	-0.1001	0.0261	-3.84	0.0002
Intermediate Dummy	-0.0742	0.0271	-2.74	0.0065
Factor1	0.1800	0.0143	12.60	<.0001
Factor2	0.0515	0.0107	4.80	<.0001
Industrial Dummy	0.0269	0.0247	1.09	0.2776

Total Pay

Variable	Estimate	Std. Err.	T-Stat	P-Value
Intercept	20.01	1.5970	12.53	<.0001
Intercept (std.dev)	13.39	1.4570	9.19	<.0001
Size (mean)	2.3516	0.4854	4.84	<.0001
Size (std.dev)	2.9423	0.3951	7.45	<.0001
Calls to Close	-0.0454	0.0669	-0.68	0.4978
Training Length	0.2422	0.1144	2.12	0.0351
Service	0.0366	0.1211	0.30	0.7629
Turnover	-0.2809	0.6434	-0.44	0.6628
Senior Dummy	15.6032	1.3913	11.21	<.0001
Intermediate Dummy	7.9582	1.3176	6.04	<.0001
Factor1	1.3487	0.6082	2.22	0.0274
Factor2	0.0448	0.5724	0.08	0.9377
Industrial Dummy	0.3889	1.3006	0.30	0.7652

Std. Deviation (Salary/Total Pay)	0.31416
Std. Deviation (Total Pay)	13.0575
Inter-equation Correlation	-0.2058
Hansen's J - Statistic	1112.002

Table 5b

1996 Data

Salary to total Pay

Variable	Estimate	Std. Err.	T-Stat	P-Value
Intercept (mean)	0.5434	0.0280	19.41	<.0001
Intercept (std.dev)	0.3149	0.0063	50.20	<.0001
Size (mean)	-0.0152	0.0037	-4.07	<.0001
Size (std.dev)	0.0296	0.0032	9.37	<.0001
Calls to Close	-0.0035	0.0008	-4.14	<.0001
Training Length	-0.0019	0.0011	-1.63	0.1040
Service	0.0029	0.0010	2.96	0.0031
Turnover	0.0105	0.0076	1.38	0.1693
Senior Dummy	-0.0706	0.0203	-3.48	0.0005
Intermediate Dummy	-0.0648	0.0212	-3.05	0.0024
Factor1	0.1069	0.0093	11.49	<.0001
Factor2	0.0187	0.0099	1.89	0.0596
Industrial Dummy	-0.0267	0.0108	-2.48	0.0132

Total Pay

Variable	Estimate	Std. Err.	T-Stat	P-Value
Intercept (mean)	17.2346	1.8360	9.39	<.0001
Intercept (std.dev)	14.9868	4.3555	3.44	0.0006
Size (mean)	2.2117	0.2906	7.61	<.0001
Size (std.dev)	3.6906	0.5529	6.67	<.0001
Calls to Close	0.2180	0.0568	3.84	0.0001
Training Length	0.4101	0.1003	4.24	<.0001
Service	0.1952	0.1126	1.73	0.0835
Turnover	0.7801	0.8067	0.97	0.3338
Senior Dummy	15.4038	1.2472	12.35	<.0001
Intermediate Dummy	7.5190	1.2591	5.97	<.0001
Factor1	-0.1685	0.5512	-0.31	0.7599
Factor2	1.8568	0.5827	3.19	0.0015
Industrial Dummy	1.9897	1.1842	1.68	0.0933

Std. Deviation (Salary/Total Pay)	0.3806
Std. Deviation (Total Pay)	23.3581
Inter-equation Correlation	-0.2302
Hansen's J – Statistic	1608.417

Technical Appendices for
"Salesforce Compensation:
Revisiting and Extending the Agency-Theoretic Approach"

Appendix A: Theoretical Appendix

I. Comparative Statics for Total Pay

From (13) we have

(A1) $T^* = W_o + \frac{d}{2}e^{*2} + \frac{r}{2}g(s)^2 b^{*2} s^2$.

From (12) we also have

(A2) $b^* = \left[\frac{k^2 + dR(s)s^2}{k^2 + \left(d\left(r + R(s)\right)s^2\right)}\right] = \left[\frac{g(s)k^2 + d\,r\,s^2}{g(s)k^2 + \left(d\left(g(s)r + r\right)s^2\right)}\right]$ and

(A3) $e^* = \frac{b^* k g(s)}{d}$.

These directly imply that

$$T^* = W_0 + \frac{\left(k^2 + drs^2\right)g[s]^2\left(drs^2 + k^2 g[s]\right)^2}{2d\left(drs^2 + \left(k^2 + drs^2\right)g[s]\right)^2} .$$

From these, we can proceed to analyze comparative static effects on total pay. Below, the "*" superscript is assumed for all derivatives.

Firm Size (s)

Note that the sign of $\frac{\partial T}{\partial s}$ is the same as the sign of $\frac{\partial T}{\partial g[s]}$. We therefore directly calculate this last expression as:

$$\frac{\partial T}{\partial g[s]} = \frac{\left(k^2 + drs^2\right)g[s]\left(drs^2 + k^2 g[s]\right)\left(d^2 r^2 s^4 + 2dk^2 rs^2 g[s] + \left(k^4 + dk^2 rs^2\right)g[s]^2\right)}{d\left(drs^2 + \left(k^2 + drs^2\right)g[s]\right)^3} ,$$

which is unambiguously positive.

Firm Risk Aversion (r)

The firm's risk aversion is the ratio of ρ to g[s]. Here, we examine the impact of a change in ρ itself on total pay. Clearly, an increase in ρ increases the firm's risk aversion.

From (A2), we can show $\frac{\partial b^*}{\partial r} > 0$. Then it follows that $\frac{\partial C(e)}{\partial r} > 0$. Since $\frac{\partial T^*}{\partial r} = \frac{\partial C(e)}{\partial b^*}\frac{\partial b^*}{\partial r} + \frac{\partial\left(\frac{r}{2}\left[g(s)sb^*\right]^2\right)}{\partial r}$, it is straightforward to show that $\frac{\partial T^*}{\partial r} > 0$.

Salesperson Risk Aversion (r)

$$\frac{\partial T}{\partial r} = \frac{s^2 g[s]^2\left(drs^2 + k^2 g[s]\right)^2\left(drs^2 - \left(k^2 + drs^2\right)g[s]\right)}{2\left(drs^2 + \left(k^2 + drs^2\right)g[s]\right)^3} .$$

The sign of this derivative is the sign of

$$\left(drs^2 - \left(k^2 + drs^2\right)g[s]\right) = g[s]\left[ds^2\left(\frac{r}{g[s]} - r\right) - k^2\right] .$$

When the salesperson is more risk-averse than the firm (i.e., $r < \frac{r}{g[s]}$), this expression is clearly negative and thus $\frac{\partial T}{\partial r} < 0$. More generally, $\frac{\partial T}{\partial r} < 0$ whenever $\left(\frac{r}{g[s]} - r\right) < \frac{k^2}{ds^2}$.

Variance (s^2)

Let $s^2 \equiv Z$ in our expression for total pay. Then:

$$\frac{\partial T}{\partial Z} = \frac{rg[s]^2\left(drZ + k^2 g[s]\right)\left(d^2r^2Z^2 + dZ\left(2k^2 + drZ\right)rg[s] - \left(k^4 + dk^2rZ\right)g[s]^2\right)}{2\left(dZr + \left(k^2 + drZ\right)g[s]\right)^3} ,$$

whose sign is the sign of:

$$\left(d^2r^2Z^2 + dZ\left(2k^2 + drZ\right)rg[s] - \left(k^4 + dk^2rZ\right)g[s]^2\right) ,$$

which is a quadratic in ρ^2. Clearly, when ρ=0, the derivative $\frac{\partial T}{\partial Z}$ is negative, so we seek the larger of the two roots of this quadratic. Solving for the roots, we find that

$$r > \left(\frac{g[s]}{2dZ}\right)\left(\sqrt{8k^4 + 8dk^2rZ + d^2r^2Z^2} - 2k^2 - drZ\right)$$

guarantees that $\frac{\partial T}{\partial Z} > 0$. This is a strictly positive value for ρ, thus establishing that for "low" values of ρ, total pay *falls* with the variance in sales, but for high enough values of ρ, total pay in fact *rises* with the variance in sales.

Opportunity Cost (W_o)

By simple differentiation: $\frac{\partial T^*}{\partial W_o} = 1 > 0$.

Base Sales (h)

By observation: $\frac{\partial T^*}{\partial h} = 0$.

Marginal Productivity (k)

As in (A4), we can show that $\frac{\partial C(e)}{\partial k} > 0\, and\, \frac{\partial b^*}{\partial k} > 0$. It then follows that $\frac{\partial T^*}{\partial k} > 0$.

Cost of Effort (d)

Noting that $C(e) = \frac{d}{2}e^{*2} = \frac{\left(b^*kg(s)\right)^2}{2d}$, we can write

(A4) $\frac{\partial C(e)}{\partial d} = -\frac{\left(b^*kg(s)\right)^2}{d^2} + \frac{\left(kg(s)\right)^2}{2d}\frac{\partial b^*}{\partial d}$. But from (A2) $\frac{\partial b^*}{\partial d} < 0$. Hence $\frac{\partial C(e)}{\partial d}$ <0, which in turn implies that $\frac{\partial T^*}{\partial d} < 0$.

II. Comparative Statics for Salary to Total Pay Ratio

As we have already proven the signs of the comparative statics with respect to total pay, we generally examine here the comparative static effects of various parameters on salary. When the salary comparative-static effect has the opposite sign from the total-pay comparative-static effect, we can unambiguously sign the comparative-static effect of that parameter on the *ratio* of salary to total pay.

We use another insight to sign several of the derivatives in this section. Recall that the salesperson's SCE, reported in equation (7) above, is:

$$(7) \qquad SCE = a + b[g(s)(h+ke)] - \frac{d}{2}e^2 - \frac{r}{2}b^2 g(s)^2 s^2 .$$

In the second-best solution, we know that effort will be allocated by the salesperson according to the rule $e = \frac{b\,g(s)k}{d}$, implying that we can rewrite SCE as follows:

$$\begin{aligned} SCE &= a + bg[s]h + \frac{b^2 g[s]^2 k^2}{2d} - \frac{r}{2} b^2 g[s]^2 s^2 \\ &= a + bg[s]h + \frac{b^2 g[s]^2}{2}\left(\frac{k^2}{d} - rs^2\right). \end{aligned}$$

The first element of the SCE expression above is simply the salesperson's salary. The second term is the commission payment the salesperson will get that is due to the *intercept* term of the sales response function – that is, that will be awarded to the salesperson regardless of what effort s/he exerts or what sales s/he achieves. The last term is the net utility value given to the salesperson as a result of having exerted effort on behalf of the firm, after accounting for the disutility of acting under risk. It comprises (a) the *commission payment* resulting from the exertion of effort, (b) the *disutility* from having exerted that effort, and (c) the *disutility* due to having acted under risk. It is sensible to assume that this net utility term as a whole is positive – in other words, that the marginal utility effect of exerting effort outweighs the disutility of bearing risk. Imposing this assumption implies a restriction on the parameter space[13] as follows:

$$\left(\frac{k^2}{d} - rs^2\right) > 0 \ , \quad \text{or equivalently,} \quad \left(k^2 - drs^2\right) > 0 \ .$$

This will be useful in the comparative-static signing process below. Finally, the expression for equilibrium salary is:

$$a = W_0 + \frac{d}{2}\left(e^*\right)^2 + \frac{r}{2} g[s]^2 b^2 s^2 - bg[s]\left(h + ke^*\right)$$

$$= W_0 - \frac{g[s]\left(drs^2 + k^2 g[s]\right)\left(2d^2hrs^2 + d\left(rs^2\left(k^2 - drs^2\right) + 2h\left(k^2 + drs^2\right)\right)g[s] + \left(k^4 - dk^2rs^2\right)g[s]^2\right)}{2d\left(drs^2 + \left(k^2 + drs^2\right)g[s]\right)^2}$$

[13] In our empirical results we find that for a small set of firms the effect of firm size is contrary to our theoretical hypothesis. A possible explanation is that this restriction does not hold for those firms.

Firm Size (s)

The derivative of salary with respect to firm size will be of the same sign as the derivative of salary with respect to g[s]. We therefore directly calculate this derivative as:

$$\frac{\partial a}{\partial g[s]} = \frac{-(\Gamma_1 \Gamma_2)}{d\left(drs^2 + \left(k^2 + drs^2\right)g[s]\right)^3} . \quad ,$$

where

$$\Gamma_1 = d^2 r^2 s^4 + 2dk^2 rs^2 g[s] + \left(k^4 + dk^2 rs^2\right)g[s]^2 \quad \text{and}$$

$$\Gamma_2 = d^2 hrs^2 + d\left(rs^2\left(k^2 - drs^2\right) + h\left(k^2 + drs^2\right)\right)g[s] + \left(k^4 - dk^2 rs^2\right)g[s]^2 \quad .$$

The sign of $\frac{\partial a}{\partial g[s]}$ is the opposite of the sign of Γ_2. But because we have already established that $\left(k^2 - drs^2\right) > 0$, it is clear that Γ_2 is positive. Hence, $\frac{\partial a}{\partial g[s]} < 0$ unambiguously, and because $\frac{\partial T}{\partial g[s]} > 0$ was established above, we have that

$$\frac{\partial (a/T)}{\partial g[s]} < 0 \quad .$$

Firm Risk Aversion (r)

We have that:

$$\frac{\partial a}{\partial r} = \frac{drs^4 g[s]^2 \Gamma_3}{\left(drs^2 + \left(k^2 + drs^2\right)g[s]\right)^3} \quad , \quad \textit{where}$$

$$\Gamma_3 = -d^2 hrs^2 - d\left(rs^2\left(k^2 - drs^2\right) + h\left(k^2 + drs^2\right)\right)g[s] + \left(-k^4 + dk^2 rs^2\right)g[s]^2 \quad .$$

Given that $\left(k^2 - drs^2\right) > 0$, Γ_3 is less than zero; since all other terms in $\frac{\partial a}{\partial r}$ are positive, $\frac{\partial a}{\partial r}$ is itself negative. Because $\frac{\partial T}{\partial r}$ is positive, this directly implies that $\frac{\partial (a/T)}{\partial r} < 0$.

Salesperson Risk Aversion (r)

$$\frac{\partial a}{\partial r}=\frac{s^2 g[s]^2\left(drs^2+k^2 g[s]\right)\Gamma_4}{2\left(drs^2+\left(k^2+drs^2\right)g[s]\right)^3}\,,\quad where$$

$$\Gamma_4=d^2rs^2\left(2h+rs^2\right)+d\left(rs^2\left(4k^2-drs^2\right)+2h\left(k^2+drs^2\right)\right)g[s]+\left(3k^4-dk^2rs^2\right)g[s]^2\ .$$

Given that $\left(k^2-drs^2\right)>0$, Γ_4 is positive; since all other terms in $\frac{\partial a}{\partial r}$ are positive, $\frac{\partial a}{\partial r}$ is itself positive. Further, because $\frac{\partial T}{\partial r}$ is generally negative, this implies that $\frac{\partial(a/T)}{\partial r}>0$.

Variance (s^2)

Let $s^2\equiv Z$ in our expression for salary. Then:

$$\frac{\partial a}{\partial Z}=\frac{rg[s]^2\Gamma_5}{2\left(drZ+\left(k^2+drZ\right)g[s]\right)^3}\,,\quad where$$

$$\Gamma_5=d^3Z^3r^3s^2+d\left(rZ\left(k^2-drZ\right)+2h\left(k^2+drZ\right)\right)g[s]+\left(k^4-dk^2rZ\right)g[s]^2\ .$$

Because $\left(k^2-drs^2\right)>0$, Γ_5 is positive; since all other terms in $\frac{\partial a}{\partial Z}$ are positive, $\frac{\partial a}{\partial Z}$ is itself positive: salary *rises* as the variance in the sales response function rises. Further, recall that $\frac{\partial T}{\partial Z}$ is negative when the firm is not "too" risk averse, in which case $\frac{\partial(a/T)}{\partial Z}>0$. If, instead, the firm is very risk averse (see the calculation of $\frac{\partial T}{\partial Z}$ above for the threshold value of ρ), then $\frac{\partial T}{\partial Z}$ can be positive. However, even when total pay *also* rises with the variance in sales, we can show that the *ratio* of salary to total pay always rises with sales variance. Directly calculating, we get:

$$\frac{\partial(a/T)}{\partial Z} = \frac{2drg[s]^3\Gamma_6}{(\Gamma_7)^2}, \quad where$$

$$\begin{aligned}\Gamma_6 = {} & d^4hZ^2r^2\left(2k^2W_0 + dZ^2r^2\right) + \\ & d^3Zr\left(4k^4W_0Zr + dk^2Z^3r^3 + h\left(4k^4W_0 + d^2rZ^3r^2 + 4dk^2Z\left(rW_0 + Zr^2\right)\right)\right)g[s] + \\ & d^2k^2\left(4k^2Zr\left(2k^2W_0 + dZ\left(rW_0 + Zr^2\right)\right) + h\left(2k^4W_0 + 2d^2rZ^2\left(rW_0 + Zr^2\right) + dk^2Z\left(4rW_0 + 5Zr^2\right)\right)\right)g[s]^2 + \\ & dk^4\left(4k^4W_0 + d^2hrZ^2r + 2dk^2Z\left(2rW_0 + r\left(h + 3Zr\right)\right)\right)g[s]^3 + 4dk^8Zrg[s]^4 + k^{10}g[s]^5 \quad and\end{aligned}$$

$$\begin{aligned}\Gamma_7 = {} & 2d^3W_0Z^2r^2 + 4d^2W_0Z\left(k^2 + drZ\right)rg[s] + \\ & d\left(k^2 + drZ\right)\left(2k^2W_0 + dZ\left(2rW_0 + Zr^2\right)\right)g[s]^2 + 2dk^2Z\left(k^2 + drZ\right)rg[s]^3 + \left(k^6 + dk^4rZ\right)g[s]^4 \quad .\end{aligned}$$

Since all terms in both Γ_6 and Γ_7 are positive, as are the other terms of $\frac{\partial(a/T)}{\partial Z}$, it is clear that

$$\frac{\partial(a/T)}{\partial Z} > 0 \ .$$

Opportunity Cost (W_o)

Salary clearly rises with W_0; $\frac{\partial a}{\partial W_0} = 1$. However, total pay also rises with W_0. However, note that we can rewrite the ratio of salary to total pay as:

$$\frac{a}{T} = \frac{W_0 + X_1 - X_2}{W_0 + X_1} \ ,$$

where neither X_1 nor X_2 is a function of W_0. The derivative of this expression with respect to W_0 is simply $\frac{X_2}{(W_0 + X_1)^2}$, which is clearly positive. We therefore have unambiguously that the ratio of salary to total pay *rises* with an increase in the salesperson's opportunity cost of time:

$$\frac{\partial(a/T)}{\partial W_0} > 0 \ .$$

Base Sales (h)

The derivative of salary with respect to base sales, *h*, is:

$$\frac{\partial a}{\partial h}=\frac{-g[s]\left(drs^{2}+k^{2}g[s]\right)}{drs^{2}+\left(k^{2}+drs^{2}\right)g[s]},$$

which is clearly negative. Meanwhile, recall that total pay does not change at all with *h*. Hence, we have unambiguously that:

$$\frac{\partial\left(a/T\right)}{\partial h}<0 .$$

Marginal Productivity (k)

The derivative of salary with respect to the marginal productivity of sales effort, *k*, is:

$$\frac{\partial a}{\partial k}=\frac{-kg[s]^{2}\Gamma_{8}}{d\left(drs^{2}+\left(k^{2}+drs^{2}\right)g[s]\right)^{3}}, \quad where$$

$$\begin{aligned}\Gamma_{8}=&d^{3}r^{3}s^{6}+d^{2}rs^{4}\left(3k^{2}r+dr\left(2h+rs^{2}\right)\right)g[s]+\\&ds^{2}\left(3k^{4}r+2drh\left(drs^{2}+k^{2}\right)+2drrs^{2}\left(2k^{2}-drs^{2}\right)\right)g[s]^{2}+\\&\left(k^{6}+dk^{2}rs^{2}\left(3k^{2}-2drs^{2}\right)\right)g[s]^{3} .\end{aligned}$$

Because $\left(k^{2}-drs^{2}\right)>0$, $\Gamma_8>0$, and thus, $\frac{\partial a}{\partial k}<0$. We know that total pay *rises* as *k* increases; hence, the ratio of salary to total pay falls with *k*:

$$\frac{\partial\left(a/T\right)}{\partial k}<0.$$

Cost of Effort (d)

Finally, salary changes with changes in the cost of effort, *d*, as follows:

$$\frac{\partial a}{\partial d}=\frac{kg[s]^{2}\Gamma_{8}}{2d^{2}\left(drs^{2}+\left(k^{2}+drs^{2}\right)g[s]\right)^{3}},$$

where Γ_8 is as defined above. Thus, salary is increasing in the cost of effort; because total pay is decreasing in the cost of effort, we have that

$$\frac{\partial\left(a/T\right)}{\partial d}>0.$$

Appendix B: Estimation Details

Our analysis has two dependent variables, namely

(i) Salary to Total Pay Ratio (henceforth 'v')
(ii) And Total Pay (henceforth 'T')

Note that, by construction, v is bounded between zero and one (or more generally a and b) with point mass at both 0 and 1. In other words, there are a number of firms located at $v = 0$ and $v = 1$. (See Figures 1 and 2).

Generalized Method of Moments (GMM) Estimation

The idea behind GMM estimation is to set up an objective function based on orthogonal moment conditions. The minimization of this objective function results in estimates of the parameters of interest. In other words, GMM estimates the parameter vector by minimizing a weighted sum of squares of the differences between the population moments and the sample moments. Therefore, in order to set up the procedure we need to specify (a) the moment conditions and (b) the weighting matrix. Details are provided in the following paragraphs.

Moment Conditions

We begin by defining the moment conditions based on the two dependent variables. Since the regression of *T* is a simple OLS problem we have can write $E\left(T \mid \mathbf{z}_i, j\right) = z'j$. In the above, z is a vector of explanatory variables and j are relevant parameters.

We also assume that v is distributed normally with mean $m_v = x'g$ and variance t^2. Again, x is a vector of explanatory variables while g and t are parameters. The density of v, however, is censored at a and b. In our case ($a = 0, b = 1$). These assumptions allow us to express the expectation of v as (see e.g. Greene 1997)

$$E(v \mid x, g) = a\Phi\left(l_a\right) + b\left[1 - \Phi\left(l_b\right)\right] + \left[\Phi\left(l_b\right) - \Phi\left(l_a\right)\right]x'g + t\int_{l_a}^{l_b} x f\left(x\right)dx \qquad \text{(A1)}$$

with

$$l_j = \left(\frac{j - x'g}{t}\right), j = a, b$$

and $\{\Phi(\cdot), f(\cdot)\}$ are the standard normal CDF and PDF respectively. (See Datar *et al.* 1997 for a marketing application of the GMM approach to estimating the Double Limit Tobit based on equation 1 above).

We can use this information to write down moment conditions of the form

$$m_1\left(\mathbf{v},\mathbf{x},g\right)=\frac{1}{n}\sum_{i=1}^{n}\left(v_i-E\left(v\mid\mathbf{x}_i,g\right)\right)\bullet y\ (\mathbf{x}_i)\ . \qquad \text{(A2)}$$

The function y is any positive increasing function which facilitates identification by allowing the exogenous variables to act as instruments.[14] A similar condition can be written down for total pay :

$$m_2\left(\mathbf{T},\mathbf{z},j\right)=\frac{1}{n}\sum_{i=1}^{n}\left(T_i-E\left(T\mid\mathbf{z}_i,j\right)\right)\bullet y\ (\mathbf{z}_i)\ , \qquad \text{(A3)}$$

with $E\left(T\mid\mathbf{z}_i,j\right)=z'j$. Now, let $m=\left\{m_1,m_2\right\},q=\left\{g,j\right\}$, $\mathbf{y}=\left\{\mathbf{v},\mathbf{T}\right\}$, $\mathbf{w}=\left\{\mathbf{x},\mathbf{z}\right\}$ and let $\boldsymbol{\Omega}$ be some positive definite weighting matrix. Then:

$$\hat{q}\in \text{argmin}\ \Gamma(q)=\left[\mathrm{m}\left(\mathbf{y},\mathbf{w},q\right)\right]'\mathbf{O}\left[\mathrm{m}\left(\mathbf{y},\mathbf{w},q\right)\right]. \qquad \text{(A4)}$$

This gives us a GMM approach to estimating the parameters in question. The method is efficient, consistent and robust (Hansen 1982).

The Optimal Weighting Matrix

The choice of the weighting matrix is critical to efficient estimation in GMM procedures. A simple (but efficient) choice is (Hansen 1982):

$$\mathbf{O}=\sum_{i=1}^{n}\left[m(\mathbf{y},\mathbf{w},q)\right]\left[m(\mathbf{y},\mathbf{w},q)\right]' \qquad \text{(A5)}$$

The two-step estimation proceeds as follows. First estimate

$$\hat{q}_1\in \text{argmin}\ \Gamma_1(q)=\left[\mathrm{m}\left(\mathbf{y},\mathbf{w},q\right)\right]'\left[\mathrm{m}\left(\mathbf{y},\mathbf{w},q\right)\right]. \qquad \text{(A6)}$$

Then compute

$$\hat{\mathbf{O}}_1=\sum_{i=1}^{n}\left[m(\mathbf{y},\mathbf{w},\hat{q})\right]\left[m(\mathbf{y},\mathbf{w},\hat{q})'\right], \qquad \text{(A7)}$$

which is then used to compute the second stem GMM estimates as

[14] For the purposes of this study we assumed that $y\ (v)=v$ and that $\tau=1$.

$$\hat{q}_2 \in \operatorname{argmin} \Gamma_2(q) = \left[\mathrm{m}(\mathbf{y}, \mathbf{w}, q) \right]' \hat{\mathbf{O}}_1 \left[\mathrm{m}(\mathbf{y}, \mathbf{w}, q) \right] \qquad \text{(A8)}$$

Rather than adopt the static (but optimal) weighting matrix approach advocated by Hansen (1982), we use an iterative GMM procedure (See Hanson, Heaton and Yaron 1996) which exhibits better small sample properties. In this approach the estimation does not stop at the second step but continues until some pre-specified convergence criteria (ζ) has been reached. In other words, start as in the two step approach but continue iterating until

$$\left\| \Gamma_t(\hat{q}_t) - \Gamma_{t-1}(\hat{q}_{t-1}) \right\| \leq z \ .$$

The optimal estimates are obtained as $q^* = \hat{q}_t$.

Incorporating Heterogeneity

To incorporate heterogeneity we re-write the moment conditions as

$$\tilde{m}_1(\mathbf{v}, \mathbf{x}, b) = \frac{1}{n} \sum_{i=1}^{n} \left(\int \left[\left(v_i - E(v \mid \mathbf{x}_i, g) \right) f(g \mid \bar{g}, t_g) \right] dg \bullet \right) y(\mathbf{x}_i) \qquad \text{(A9)}$$

and

$$\tilde{m}_2(\mathbf{T}, \mathbf{z}, j) = \frac{1}{n} \sum_{i=1}^{n} \left(\int \left[\left(T_i - E(T \mid \mathbf{z}_i, j) \right) f(j \mid \bar{j}, t_j) \right] dj \bullet \right) y(\mathbf{z}_i) \qquad \text{(A10)}$$

and make relevant replacements in the GMM objective function to obtain

$$\hat{q}_{SMM} \in \operatorname{argmin} \Gamma(q) = \left[\tilde{\mathrm{m}}(\mathbf{y}, \mathbf{w}, q) \right]' \tilde{\mathbf{O}} \left[\tilde{\mathrm{m}}(\mathbf{y}, \mathbf{w}, q) \right]. \qquad \text{(A11)}$$

We use a Monte-Carlo approach to approximate the integrals. This implements a *Simulated (Generalized) Method of Moments (SMM)* estimator. (More details are available from the authors).

References (for Appendix B only)

Datar S. *et al.* (1997), "Advantages of Time-Based New Product Development in a Fast Cycle Industry," *Journal of Marketing Research*, vol. 34, 36-49.

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Figure 1: Ratio of Salary to Total Pay – Histogram

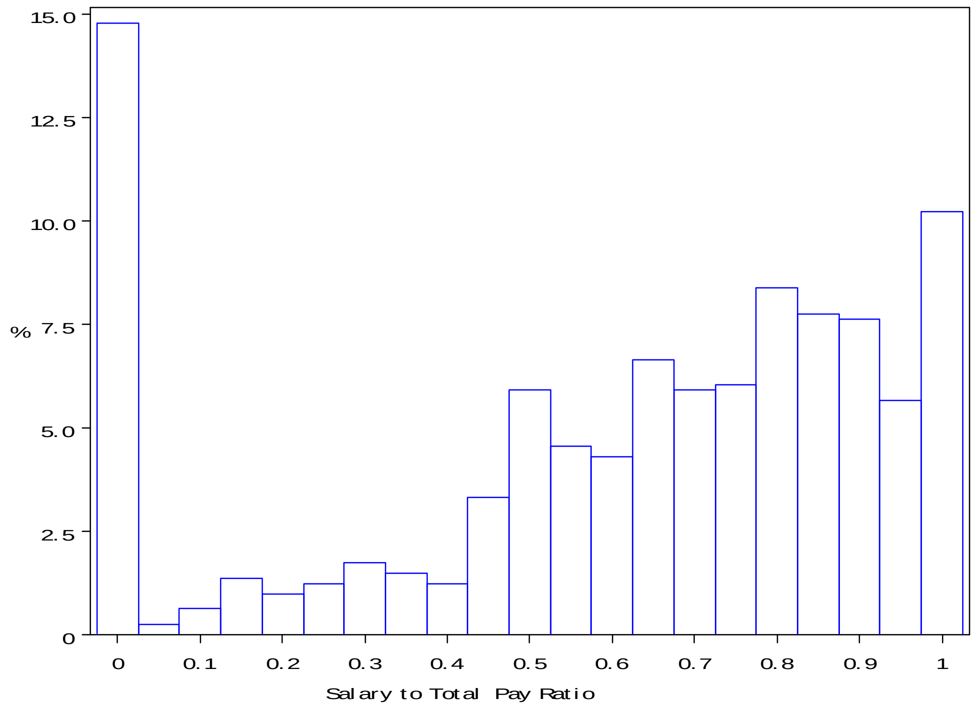

Figure 2: Total Pay –Histogram