Price Delegation and Performance Pay:

Evidence from Industrial Sales Forces†

Desmond (Ho-Fu) Lo

Santa Clara University

Wouter Dessein

Columbia University

Mrinal Ghosh

University of Arizona

Francine Lafontaine

University of Michigan

laf@umich.edu

July 2015

This article has been accepted for publication in the *Journal of Law, Economics and Organization*, published by Oxford University Press.

Abstract

Delegation is a central feature of organizational design that theory suggests should be aligned with the intensity of incentives. We explore a specific form of delegation, namely price delegation, whereby firms allow sales people to offer a maximum discount from the list price to their customers. We develop a model of the price delegation decision based on information acquisition that relies on characteristics of our empirical context of industrial sales. Using data on individual sales people, one per firm from a survey of 261 firms, we show that, consistent with predictions from our model, sales people are given more pricing authority when they are more experienced and more capable, when there is less environmental uncertainty, and, to a lesser extent, when customer valuations for the product are more variable. Also consistent with our model, we show that price delegation is increasing in the intensity of incentives given to agents.

(JEL codes: D23; D82; L22; M52)

1. INTRODUCTION

The allocation of decision rights and the choice of compensation schemes are both important features of organizational design, reflecting how firms motivate their employees and coordinate their activities (Jensen and Meckling, 1976; 1992; Prendergast, 2002; Brickley, Smith, and Zimmerman, 2009). Despite their importance, the empirical literature on these, and on the connection between them, remains small compared to the large set of theoretical contributions. This is especially the case given the variety of settings in which both incentive pay and delegation occur, and the different forms they can take. Much of the empirical literature, moreover, has focused *either* on the study of compensation schemes, *or* on the allocation of decision rights.[1] The limited empirical literature on the relationship between compensation and delegation, however, has shown that company executives who are given more authority also operate under higher-power incentive regimes (Nagar, 2002, for bank-branch managers; Shi, 2011, for CEOs; and Wulf, 2007, for divisional managers). Similarly, authors have found evidence that employees who are given more jurisdiction over bundles of tasks they perform are more likely to be paid incentives (Macleod and Parent, 1999 and Ben-Ner et al., 2012 for U.S. workers; Foss and Laursen, 2005, for Danish sales people; DeVaro and Kurtulus, 2010, for British workers; and DeVaro and Prasad, 2013, for workers whose jobs the authors classify as simple).[2] Kato and Morishima (2002) further show that participatory practices and performance pay are associated with higher productivity in Japanese firms.

In this paper, we examine factors that affect the extent of delegation, and the relation between delegation and compensation plans, in the context of industrial equipment

manufacturing firms and their sales forces. Industrial equipment sales are a particularly suitable context to consider these issues for several reasons.

First, delegation in this sector takes a very specific form: sales persons are given the authority to unilaterally offer price discounts up to a certain percentage – say 10% – off the list price *without* having to confer with their superiors. Discounts beyond the authorized level require explicit approval from the supervising manager. This level of pricing authority, tailored to and accorded to individual sales persons, is our measure of price delegation. This measure is cardinal, in contrast to the typical measures used in the literature, which have been either perceptual - often captured by indicator variables representing the existence of a bundle of participation and decision rights (MacLeod and Parent, 1999; Nagar, 2002; Foss and Laursen, 2005; Ben-Ner et al., 2012; DeVaro and Kurtulus, 2010) – or categorical measures of delegation inferred from internal hierarchy (Shi, 2011; Wulf, 2007). Moreover, since pricing authority in industrial sales is customized to an individual agent, its determinants include not only firm and environmental factors emphasized in the literature (e.g., Acemoglu et al., 2007; Ben-Ner et al., 2012; McElheran, 2014), but also agent characteristics such as experience and skills.

Second, as opposed to other sales force contexts where quotas and bonuses play a large role, the incentive component of the compensation scheme for industrial equipment sales people predominantly takes the form of sales commissions that are proportional to revenues generated (e.g., John and Weitz, 1989; Oyer, 1998). This makes it possible to measure *ex ante* incentive pay contrary to other contexts where authors have access to

only *ex post*, realized performance pay (e.g., Nagar, 2002; Wulf, 2007) or categorical measures of incentive pay (e.g., Foss and Laursen, 2005; DeVaro and Kurtulus, 2010; Shi, 2011; DeVaro and Prasad, 2013).[3]

Third, the type of equipment sold by the sales persons in our data is very complex. Because customers' needs also are idiosyncratic, the sales process involves customization and the assessment of customer values for proposed solutions. As a result, manufacturers tend to rely on a direct sales force rather than independent dealers as their main channel of distribution (e.g., Anderson and Schmittlein, 1984; Zoltners, Sinha, and Lorimer, 2006: 2).

Finally, industrial equipment firms design their pay schemes for sales people at the level of the sales force (or a sales tier within it) and offer their compensation package on a take-it-or-leave-it basis (John and Weitz, 1989; Lo et al., 2011; Daljord, Misra, and Nair, 2014). The level of pricing authority, in contrast, is conferred at the individual sales-person level. The implication of these features of our empirical setting is that even though firms may eventually align their compensation scheme to some expected level of price delegation for their sales people, price delegation is likely to be affected by the compensation scheme, while the reverse is less likely. This is in contrast to what is assumed in Prendergast (2002), where agents are given more decision-making authority when they have an informational advantage over their employer, which in turn leads the firms to give them higher powered incentive pay.[4]

Given the above, we draw upon the notions of constrained delegation and information acquisition from Holmstrom (1977; 1984) and Aghion and Tirole (1997) to develop a

theoretical model of price delegation that builds upon the features of our empirical context. We then test the implications of our model using a cross-sectional data set collected via survey from a sample of 261 firms, where questions were asked about one sales person per firm. The central mechanism in our model is that pricing flexibility is more valuable when the sales person is more knowledgeable about customer valuations. As the sales person is paid a fraction of revenues rather than profits, he has an incentive to price too low. For that reason, the firm optimally constrains the price the agent can set to be above some lower bound.[5] The more knowledgeable the sales person is, however, the better aligned are the sales person's pricing incentives and so the more pricing authority he receives. Thus, higher commission rates, which lead the agent to put more effort towards learning about customer valuations, also lead to more pricing authority.

Consistent with the predictions of our model, we find a strong positive effect of commission rates on the extent of price delegation. We also find evidence that sales people with longer tenure or higher ability are given more pricing authority. Finally, we find some evidence that firms use a higher level of price delegation when customers are more heterogeneous, i.e. when the agent's capacity to elicit customer values is more valuable. In contrast, when industry demand fluctuates more or technology changes rapidly, we find that the sales person is provided with less pricing authority, consistent with the notion that the firm has an informational advantage with regard to market and technological trends in those contexts.

The paper is organized as follows. In the next section, we discuss in more detail features of the industrial equipment sales context. In Section 3 we present our model. We

describe our data collection process, and the measures used in our empirical analyses, in Section 4. We discuss our empirical specification and results in Section 5. We conclude in Section 6.

2. INDUSTRIAL EQUIPMENT SALES

Industrial equipment manufacturers sell capital equipment and machines that are used by their customers in their own production, operations or administrative processes. In the 1987 Standard Industrial Classification (SIC), industrial equipment manufacturers are classified in four separate industries, namely non-electrical machinery including computer equipment (SIC 35), electrical and electronic machinery (SIC 36), transportation equipment (SIC 37), and instruments (SIC 38). The type of equipment they sell is often very complex, reflecting a combination of scientific, engineering, and software technologies that can change in important ways and relatively frequently. More often than not, the equipment needs to be matched with, and tailored to, the specific needs of the customers. The assessment of the customer's needs, and of the value they place on any given product, often requires long periods of interaction between the manufacturer's sales person and the customer's agents. The complexity of the technical knowledge, the pace of technical change, and the variation in customer needs and resulting valuations combine to create a challenging environment for those sales people involved in industrial equipment sales.

The sales process for industrial equipment has two other features that distinguish it from most other markets. First, potential customers usually provide detailed project specifications and source their equipment via "requests for quotations – RFQs. " The

quantities specified in these requests for quotations are usually fixed, meaning that the customer sets quantities in advance. Thus from a modeling perspective we can treat customers as having something akin to unit demand. Second, to understand customer's needs and valuation of a piece of equipment, sales people must engage in a deliberate process, which can take months to complete. This process requires that the sales person demonstrate skills related to technical specification design and customization, as well as those related to relationship-building with multiple contacts and units within the buying firm, and to price negotiation, and so on. The sales person also must apportion effort to these different aspects of the sales process. Firms provide technical and sales training as well as in-house support (e.g., the sales person can request the assistance of an in-house technical design engineer to solve a vexing specification problem for a particular customer) to aid the sales process.

In part because of this complexity and the length of the sales cycle, compensation plans for these sales people are usually composed of just a fixed salary and a sales-based commission. As in many other sales contexts, the main metric used to calculate the commission is the revenue generated by an individual sales person. Managers indicated that the key reason for using revenues rather than gross or net margins is that revenues are easier to observe and less likely to be distorted, or, as one manager stated, "margins can be easily manipulated … the sales person would not know if he is cheated on and worse he would never believe he is not cheated on … we don't want such headaches." Further, in many cases the equipment sold by these sales people not only requires significant modifications to fit a customer's requirements but also extensive post-sales

installation and technical consulting and advisory information from the vendor to bring the equipment "on-line" with the rest of the operations. Computing margins becomes even more difficult in these circumstances. In essence, revenue-based incentives are popular for sales people in these industries because of their ease of implementation (see also Albers, 1996: 5).

The managers also indicated that, to the best of their knowledge, the commission component of the compensation is almost always linear, i.e. a simple proportion of sales. They attributed the tendency to use fixed percentage commission rates, rather than increasing or decreasing schedules, to both long product sales cycles and unitary demand, where the latter implies that incentivizing customers to buy more (to make a quota at the end of a pay period, for example) is not a relevant feature of these capital goods markets. Long sales cycles also mean that many potential sales prospects can spill over from one fiscal period to the next, which would create problems of attribution – to the year when the sale was initiated or concluded – if the firms used non-linear commission plans.

Discussions with managers revealed that quota-based bonuses are uncommon in this sector, contrary to other contexts.[6] When used, they represent only a small component of the sales person's total compensation for the year, typically no more than 5%. In many cases, bonuses are provided in kind – e.g., an all-paid vacation for the family – rather than cash, in which case they never appear in our compensation data. Quotas may be used as well. These would be set at the start of the fiscal year based on a variety of considerations, including territory potential, competitive intensity, sales person tenure, past performance, and so on. Firms rarely penalize a sales person for missing his or her

quota for a year or two. This is to account for the long sales cycles – sales people can go for months without making a single sale. However, missing one's quota consistently over a longer horizon of time might lead to some interventions, for example, more managerial supervision of the call plans and sales processes, or ultimately termination.

Finally, as mentioned in the introduction, and in contrast to executive compensation schemes that tend to be individualized, sales people in this sector usually are paid based on pay plans devised at the level of the whole sales force or sales group (see also John and Weitz, 1989; Lo et al., 2011; Daljord, Misra, and Nair, 2014). More precisely, sales people within a particular group or tier, selling similar products to customers with similar profiles, are offered the same compensation plan, albeit one where the fixed component may be adjusted for cost of living and travel to office "dearness" allowances. The intensity of incentives is usually based on task and desired agent characteristics but not adjusted or tailored to the characteristics of an individual sales person. The level of pricing authority, on the other hand, or the maximum percentage discount off the list price that the sales person can offer a buyer without conferring with his manager, is accorded to an individual sales person after he/she joins the firm, and it can change over time. Our interviewee-managers indicated that the primary role of the pricing authority accorded to the sales person was to enable them to tailor the price to the particular situation of a given customer, i.e., implement some level of price discrimination. List prices, on the other hand, are typically the same across all sales territories, and modified only infrequently, so as to maintain a consistent "perceived" value for the products.

Managers of sales forces in these firms also indicated that allowing their sales people to offer price discounts does not lead them to "automatically" drop price to encourage the sale (i.e., substitute price discounts for effort). They noted that both compensation and supervision curb this tendency. In particular, since their own commission revenue is based on the revenues generated from a sale, sales people are cautious about discounting. In addition, if the managers notice a repeated pattern of high discounts suggesting overuse of the sales person's discretionary authority, they bring this up with the sales person and make suggestions (including regular sales training exercises) on how the situation could be handled better from the company's point of view. Such counseling sessions make the sales person aware that he is exercising his discretionary limits too often.

3. PRICE DELEGATION AND PAY-FOR-PERFORMANCE – THE MODEL

We develop a simple model to guide our empirical specifications and generate empirical implications that we bring to the data below. Our model follows the canonical "constrained delegation" set-up of Holmstrom (1977; 1984) where a principal (e.g., an owner) optimally constrains the actions of a better-informed agent (e.g., an employee), but introduces incentives for information acquisition, as in Aghion and Tirole (1997), and applies this set-up to price delegation and price discrimination.[7] This framework suits the decision process and features of our industrial sales empirical context particularly well.

Consider an employer or firm (the principal/she), who is the sole producer of an industrial good (equipment) with production cost of c, and who employs sales people to sell its product. In what follows, we focus on the firm's problem regarding a single sales

person (the agent/he). For simplicity, this sales person is assigned to one customer who buys at most a single unit and whose value for the good equals v.

Since customers may use the equipment in different ways, its value to them differs. We therefore assume that the value of the equipment, v, for a customer is drawn from a continuous uniform distribution over $[v_L, v_H]$ with $c < v_L < v_H/2$.[8] Because the agent interacts with customers directly, we assume that he is in a better position than the principal to learn customer needs and, thus, valuations. We model this by assuming that while the principal knows only the overall distribution of customer values, the agent learns the valuation v of the customer with probability $q \in [0,1]$. With the remaining probability $1 - q$, the agent simply knows that $v \sim U[v_L, v_H]$, that is, he is equally uninformed as the principal. Hence, the main role of the sales person is to identify the value v of the consumer and price accordingly.

We further assume that q is a function of the effort, e, exerted by the sales agent, and of his tenure t at the firm (i.e., experienced sales persons are more likely to learn the customer valuation) so that $q = q(e, t)$ where $q_t > 0$, $q_e > 0$, and $q_{ee} \leq 0$.[9] The private cost of effort for the agent is given by $g(e) \geq 0$ with $g'(e) \geq 0$, $g''(e) > 0$ and $g(0) = g'(0) = 0$. To simplify the exposition, we assume the following functional forms:

$$q(e, t) = t + \beta e, \text{ and}$$

$$g(e) = \frac{ke^2}{2},$$

where $\beta > 0$ is an agent-specific characteristic, which we equate to agent skill.[10] We assume that β and k are such that $q(\cdot) < 1$ given equilibrium effort.

In order to induce agent effort, consistent with our data, we assume that the agent is paid a fraction α of revenues, with $0 < \alpha < 1$, and a fixed wage W. For now, we posit that this commission rate α is exogenously determined, for example because of industry or historical practice. In Section 3.4 below, we discuss how α may be endogenized and how this affects the predictions from the model. The fixed wage W is set such that the agent obtains, in expectations, his reservation utility W_R.

3.1. Full pricing authority and incentive conflict

To illustrate the incentive conflict between the firm and the agent, suppose first that the agent is given complete pricing authority and that his probability of learning customer valuation q is exogenous. With probability q, the agent is informed and sets

$$p_I^A = v$$

where the superscript A stands for agent, and the subscript I indicates that the agent is informed. In other words, the agent perfectly price discriminates, and sales revenues are v. With probability $1 - q$, the agent simply knows that $v \sim U[v_L, v_H]$ and sets a price

$$p_{-I}^A = \arg\max_{p \in [v_L, v_H]} \left[\alpha p \left(\frac{v_H - p}{v_H - v_L} \right) \right]$$

where the subscript $-I$ indicates that the agent is uninformed, and $\left(\frac{v_H - p}{v_H - v_L}\right)$ is the probability that the customer buys at price p. This maximization yields

$$p_{-I}^A = \frac{v_H}{2}.$$

In contrast, if the principal were to set a price, given a commission rate α that is predetermined, she would choose[11]

$$p^P = \arg\max_{p \in [v_L, v_H]} \left[(p - c) \left(\frac{v_H - p}{v_H - v_L} \right) \right] = \frac{v_H + c}{2}.$$

Thus whenever the agent is uninformed, which happens with probability $1 - q$, there is an incentive conflict between the agent and the principal. The agent would like to set a lower price than the principal as he maximizes revenues whereas the principal maximizes profits taking production costs into account. As discussed in Section 2, incentivizing the agent based on profits per sale is not industry practice, arguably because costs are not observable or verifiable. Barring profit-based commissions, sales commissions are still desirable from the firm's perspective because they induce effort, which leads to a greater level of q in equilibrium, and hence higher expected revenues.

In contrast, whenever the agent is informed, which happens with probability q, the price he sets is equal to customer value, and as such, maximizes both profits and revenues. It follows that the average incentive conflict between agent and principal is decreasing in the probability that the agent is better informed than the principal.

3.2. Constrained delegation: optimal pricing delegation

In this section, we study the optimal pricing authority that the principal should provide to the agent. Specifically, per practice in the industry, we assume that the principal can choose a subset $S \subset [v_L, v_H]$, within which the agent will be allowed to select any price p. Optimal delegation sets and intervals were first studied by Holmstrom (1977; 1984), which were also the first papers to define the delegation problem.[12] Optimal delegation sets can implement full delegation, when the delegation set is equivalent to the (relevant) action space, or full centralization, when the delegation set is reduced to a single option corresponding to the principal's preferred price. [13]

In our setting, it is easy to see that the optimal delegation set S is an interval $[p_L, v_H] \subset [v_L, v_H]$, where p_L acts as a lower bound on the price that the agent is allowed to charge. Note that given our assumptions about customer values, the firm's list price will be set at v_H.[14] The length of the interval $[p_L, v_H]$ then characterizes the pricing flexibility or pricing authority given to the agent, and $(v_H - p_L)/v_H$ is the discount that the sales person can offer his customers, the measure of price delegation in our data below. Given the observed timing of decisions in the empirical setting of industrial sales, we assume that the principal decides on the discount, or the pricing floor p_L, *before* the sales agent puts effort towards learning the customer's valuation, and that the principal is committed to this delegation interval.[15] Full delegation is equivalent to setting $p_L = v_L$. Since $p^P > p_{-I}^A$, however, a lower bound may be valuable when the agent is likely to be uninformed, that is, when q is small. Indeed, in the extreme case in which the agent is never informed, it is optimal for the principal to let the agent charge any price $p \geq p_L = p^P$. In equilibrium, the agent then always sets $p_{-I}^A = p_L = p^P$, and it is as if pricing is centralized. Whenever $q > 0$, however, it will be optimal to set $p_L < p^P$.

For a given lower bound p_L, the expected payoff for the agent is given by

$$\Pi_A = \alpha \left[q(e) \left(\frac{v_H - p_L}{v_H - v_L} \right) \left(\frac{v_H + p_L}{2} \right) + (1 - q(e)) p_L \left(\frac{v_H - p_L}{v_H - v_L} \right) \right] - g(e) + W \qquad (1)$$

where W must be set such that Π_A equals (or exceeds) the agent's reservation utility W_R. It follows that the pay-off for the principal is given by expected gross profits minus the total compensation for the agent, or the sum of his cost of effort $g(e)$ and reservation utility W_R.

3.3. Sales effort, customer knowledge, and pricing flexibility

We now investigate the optimal effort, the resulting probability q that the agent learns customer valuation v, and the optimal level of pricing flexibility. From (1), we have

$$e^* = \frac{\beta\alpha}{2k}\frac{(v_H - p_L)^2}{v_H - v_L}$$

and hence

$$q^* = t + \frac{\beta^2\alpha}{2k}\frac{(v_H - p_L)^2}{v_H - v_L}.$$

We further define $v_L = \bar{v} - \delta$ and $v_H = \bar{v} + \delta$, where $\bar{v}$ is the mean of v. One can then verify that the probability that the agent learns the customer's valuation (q^*) is increasing in tenure (t), agent skill (β), a mean-preserving spread in customer valuation (δ), and the commission rate (α). Given our discussion above, it follows also that the incentive conflict between the firm and her agent is decreasing in agent tenure, skill, and the commission rate.

The principal decides on the optimal level of pricing authority by setting p_L to maximize

$$\Pi_P = \left[q^*\left(\frac{v_H - p_L}{v_H - v_L}\right)\left(\frac{v_H + p_L}{2} - c\right) + (1 - q^*)(p_L - c)\left(\frac{v_H - p_L}{v_H - v_L}\right)\right] - g(e^*) - W_R.$$

The first-order condition $\frac{\partial \Pi_P}{\partial p_L} = 0$ for this maximization problem can be written as (see Appendix A for details)

$$(1 - q^*)(v_H - p_L) - (p_L - c) + \frac{1}{2}(1 - \alpha)\beta\frac{\partial e^*}{\partial p_L}(v_H - p_L)^2 = 0. \qquad (2)$$

The second-order condition $\frac{\partial^2 \Pi_P}{\partial p_L^2} < 0$ will be satisfied if and only if (see Appendix A)

$$-(2-q^*)+3(1-\alpha)\frac{\beta^2\alpha}{2k}\frac{(v_H-p_L)^2}{v_H-v_L}<0, \tag{3}$$

A sufficient condition for the inequality in (3) is that

$$3(1-\alpha)\frac{\alpha\beta^2}{2k}(v_H-v_L)<1. \tag{4}$$

Hence the second-order condition will be satisfied if the cost of effort is large enough (k is not too small) or the agent's knowledge about the customer q is not too sensitive to effort (β is not too large). Under this condition, the optimal level of p_L is uniquely determined by

$$p_L^* = \max(v_L\,, p_L')$$

where p_L' is the unique *implicit* solution to (2). By rearranging terms, p_L' can be usefully rewritten as:

$$p_L' = \frac{c+(1-q^*)v_H+\frac{1}{2}(1-\alpha)\beta\frac{\partial e^*}{\partial p_L}(v_H-p_L')^2}{2-q^*}. \tag{5}$$

In Appendix A, we show the following result:

Proposition 1: *Given* (4)*, the optimal pricing authority,* $v_H-p_L^*$*, and the pricing flexibility* $(v_H-p_L^*)/v_H$*, are increasing in the commission rate* (α)*, agent tenure* (t)*, and agent skill* (β).

Proof: See Appendix A.

From Proposition 1, the optimal level of pricing flexibility is increasing in those factors that make the agent more knowledgeable, that is t and β, or motivate him to become more knowledgeable, namely α and β.

One comparative static result that is absent from Proposition 1 concerns the impact of customer heterogeneity (δ) on pricing flexibility. While one can verify from (5) that

pricing flexibility $(v_H - p_L^*)/v_H$ is increasing in a mean-preserving spread of customer values when the ability q^* of the agent to identify customer valuations is treated as exogenous, there are parameter values for which pricing flexibility is non-monotonic in δ when q^* *i*s endogenous. Intuitively, more customer heterogeneity increases the value of providing pricing flexibility to the sales agent for a given level of q. But since customer heterogeneity also affects $q_{p_L}^*$, which is the extent to which more pricing flexibility increases q^*, the impact of δ on pricing flexibility is more subtle. However, simulations strongly suggest that $(v_H - p_L^*)/v_H$ on average will be increasing in δ in a broad sample of data: in all simulations we ran, pricing flexibility was robustly increasing in δ with the exception of, in some cases, a small parameter range for δ.[16]

To keep the model parsimonious, we did not explicitly model the effect of environmental uncertainty such as uncertainty about product demand at the industry level or speed of technological change. But environmental uncertainty plays a central role in some of the literature (e.g., Prendergast, 2002, and related empirical work). For that reason, we now discuss the effect that environmental uncertainty may have on price delegation in the context of our model. Intuitively, the agent's informational advantage concerns factors that are specific to his particular client and how that customer will use the product. In contrast, given that the firm – especially a larger corporation like the ones in our sample – often hires experts in production, product development, and market analysis, it arguably is better informed about industry and technology trends than is a particular sales person. Moreover, a dynamic market and technological environment reduces the usefulness of knowledge acquired from former customers and obsolete

products. Hence, environmental uncertainty is not only "inactionable" for the agent (Shi, 2011), but it also reduces his informational advantage on customer valuation. A parsimonious way to model this would be to posit that $q(e,t) = t - \mu + \beta e$, or $q(e,t) = t + (\beta - \mu)e$. To the extent that an increase in environmental uncertainty in terms of industry demand or technological change reduces the informational advantage of the sales agent, it is captured by an increase in μ. Hence, we have the following corollary from Proposition 1:[17]

Corollary 1: *The optimal pricing authority,* $v_H - p_L^*$*, and the pricing flexibility* $(v_H - p_L^*)/v_H$*, are decreasing in environmental uncertainty as captured by an increase in* μ*.*

3.4. Endogenous commission rate

Recall that companies selling industrial equipment set compensation at the firm- or sales-force level, and compensation structures are fairly stable. In other words, the commission rate is *not* responsive to individual characteristics that change within individuals over time, such as tenure. On the other hand, companies may choose their commission rates so as to attract the appropriate types of sales people to their sales jobs (Lo et al., 2011), in particular in terms of risk aversion and sales skill. For that reason, in this section, we depart from our assumption that the commission rate α is determined by factors exogenous to the model. In particular, we assume that the agent dislikes variable pay. We model this last assumption as an additional cost that the agent bears, namely

$$R(\gamma, \alpha)$$

where $R_\alpha > 0$ and $R_{\alpha\alpha} > 0$ and where γ is an agent-specific parameter capturing his distaste for variable pay, that is, $R_\gamma > 0$ and $R_{\gamma\alpha} > 0$. It follows that for a given α and the equilibrium level of effort $e(\alpha)$, the agent's wage W must be set such that

$$W + \alpha\left[q\left(\frac{v_H - p_L}{v_H - v_L}\right)\left(\frac{v_H + p_L}{2}\right) + (1-q)p_L\left(\frac{v_H - p_L}{v_H - v_L}\right)\right] - g(e) - R(\gamma,\alpha) \geq W_R.$$

Since at the optimum, the above constraint will be binding, the principal maximizes

$$\Pi_P = q(\alpha, p_L^*)\left(\frac{v_H + p_L^*}{2} - c\right)\left(\frac{v_H - p_L^*}{v_H - v_L}\right) + \left(1 - q(\alpha, p_L^*)\right)(p_L^* - c)\left(\frac{v_H - p_L^*}{v_H - v_L}\right) - g(e) - R(\gamma,\alpha)$$
$$-W_R.$$

By the envelope theorem, the first-order condition for p_L^* remains given by (2) and the optimal level of p_L remains determined by $p_L^* = \max(v_L, p_L')$ where p_L' is the implicit solution to (5). The first-order condition for α^* is given by

$$Z = \frac{d\Pi_P}{d\alpha} = \frac{\partial \Pi_P}{\partial \alpha} + \frac{\partial \Pi_P}{\partial q^*} q_\alpha^* - g'(e^*)e_\alpha^* + \frac{d\Pi_P}{dp_L^*}\frac{\partial p_L^*}{\partial \alpha}$$

$$= -R_\alpha(\gamma,\alpha) - ke^*e_\alpha^* + q_\alpha^*\left[\left(\frac{v_H + p_L^*}{2} - c\right)\left(\frac{v_H - p_L^*}{v_H - v_L}\right) - (p_L^* - c)\left(\frac{v_H - p_L^*}{v_H - v_L}\right)\right]$$

$$= -R_\alpha(\gamma,\alpha) - ke^*e_\alpha^* + \frac{1}{2}q_\alpha^*\frac{(v_H - p_L^*)^2}{v_H - v_L} = 0,$$

where $e^* = \frac{\beta\alpha}{2k}\frac{(v_H - p_L)^2}{v_H - v_L}$ and $q^* = t + \frac{\beta^2\alpha}{2k}\frac{(v_H - p_L)^2}{v_H - v_L}$. Hence,

$$Z = -R_\alpha(\gamma,\alpha) + \frac{\beta^2(1-\alpha^*)}{4k}\frac{(v_H - p_L)^4}{(v_H - v_L)^2} = 0.$$

Since $R_{\alpha\alpha} > 0$, the second-order condition is satisfied. We further have that

$$\frac{d\alpha}{dx} = \frac{\partial Z}{\partial x} / \left(-\frac{\partial Z}{\partial \alpha}\right)$$

for $x \in \{\gamma, \beta, t\}$, where $\frac{\partial Z}{\partial \alpha} \leq 0$ and hence:

$$\frac{d\alpha}{dx} > 0 \iff \frac{\partial Z}{\partial x} = Z_x + Z_{p_L^*}\frac{dp_L^*(\alpha)}{dx} > 0. \qquad (6)$$

From (6), any variable $x \in \{\gamma, \beta, t\}$ may affect the commission rate α directly, as captured by Z_x, and indirectly through its impact on p_L^*. Intuitively, effort and incentive pay are more valuable when the sales agent has more pricing authority, as captured by $Z_{p_L^*} < 0$. Hence, any variable $x \in \{\gamma, \beta, t\}$ that increases pricing authority (i.e., for which $\frac{dp_L^*(\alpha)}{dx} < 0$), also indirectly increases the commission rate α. Thus, risk aversion γ affects α directly, but not indirectly (i.e., $Z_\gamma < 0$ but $\frac{dp_L^*(\alpha)}{d\gamma} = 0$), whereas tenure t affects α only through its impact on p_L^* ($Z_t = 0$ but $\frac{dp_L^*(\alpha)}{dt} < 0$). Finally, agent skill affects the commission rate both directly and indirectly ($Z_\beta > 0$ and $\frac{dp_L^*(\alpha)}{d\beta} < 0$). It follows that: $\frac{d\alpha^*}{d\gamma} < 0$, $\frac{d\alpha^*}{d\beta} > 0$, and $\frac{d\alpha^*}{dt} > 0$. Thus, we have the following:

Proposition 2: *The optimal commission rate, α^*, is increasing in the tenure of the agent (t) and agent skill (β), but decreasing in the agent's aversion to variable pay (γ).*

Since the optimal pricing authority is increasing in the commission rate, but is not directly affected by the agent's aversion to variable pay (γ), it follows from Proposition 2 that pricing authority is also decreasing in γ. Furthermore, the comparative statics of pricing authority with respect to agent skill and tenure, derived in Proposition 1, carry through when α^* is endogenous. Indeed, only agent skill affects both variables directly, but in the same direction.

In addition, as was the case for pricing flexibility, the impact of a mean-preserving spread in customer valuations (δ) on α^* is theoretically ambiguous. Intuitively, an increase in customer heterogeneity makes incentive pay more valuable, because a more

knowledgeable sales agent is then more valuable. This positive direct effect may be dulled or even reversed, however, by the effect of customer heterogeneity on pricing authority. Indeed, an increase in customer heterogeneity may increase the pricing floor p_L^*, thereby indirectly reducing the value of incentive pay.[18]

Finally, under the notion that environmental uncertainty undermines the ability of the sales person to obtain information on customer value, as captured by μ in $q(e,t) = t - \mu + \beta e$ or $q(e,t) = t + (\beta - \mu)e$, we obtain the standard result that incentive pay is decreasing in exogenous risk. We state this result in the following corollary:

Corollary 2: *The optimal commission rate, α^*, is decreasing in environmental uncertainty as captured by an increase in μ.*

4. DATA AND MEASUREMENT

An empirical analysis of firms' decisions to delegate pricing authority to a specific extent, and of the relationship between such delegation and the commission rates offered to sales people, requires data not only on an individual sales-person's pricing authority and compensation but also variation on key task and agent characteristics. Such data are unlikely to be available in public records. Hence, we obtained our data via a proprietary mail survey administered to sales managers in firms manufacturing durable industrial equipment selling via direct sales forces (though not necessarily exclusively so).

To ensure data quality, a number of steps were taken, including (1) detailed pilot interviews with field sales managers to ascertain the relevance of our issues to their sales contexts, (2) choosing the appropriate survey participants, and (3) constructing appropriate measures of our variables. These steps are described below.

4.1. Pilot Interviews

To better understand the issues firms face in choosing the extent of pricing authority they grant to individual sales people and designing compensation plans for them, we conducted on-site field interviews with sales managers at 16 firms. Each interviewee was directly responsible for managing the firm's direct sales force, either at the regional or national level. These interviews lasted for an average of about three hours each. We also pre-tested our survey instrument during some of these interviews. Insights from this pilot study were then used to refine the questionnaire and generate the final survey instrument. In addition, these interviews were the source of much of the information regarding how managers choose the level of pricing authority and the compensation plans of their sales people discussed in Section 2.

4.2. Selection of Survey Participants and Data Collection Procedure

To obtain quality measures of our key variables, we used a two-stage procedure to reach our survey participants. We first obtained a list of sales managers of manufacturing firms with sales exceeding $100 million in the relevant industrial sectors from two list brokers – the American List Council and Dunn and Bradstreet. The 1470 individuals on these lists were then contacted by phone. To qualify as key informants, they had to meet two criteria: they had to be primarily involved in managing the sales force for their division/firm in a well-defined customer, product, or geographic market; and their firm had to be using a direct sales force rather than contract dealers in those markets. Four telephone calls on average were required to qualify each informant. To elicit cooperation, we offered each manager a customized report summarizing the findings from our survey

and comparing their profile to the average patterns in the data. Of the initial 1470 individuals, 869 indicated that they use a direct sales force. In the second stage, we mailed questionnaires to each of these 869 respondents. After two reminders, we had obtained 264 responses. Three of these were discarded for missing data, for a final sample of 261 responses (or a response rate of 30%).

The survey questions were designed to be specific to a single sales person that these sales managers were currently supervising. To minimize selection bias on the sales person, we asked the sales manager to identify a customer who had procured their company's product over the previous fiscal year (2005) and then identify the sales person who was responsible for making that particular sale. We requested that the manager give responses pertaining to this and only this sales person. Hence, our unit of analysis is an individual sales person, with each sales person, or data point, representing a product or product line in a different firm.[19]

4.3. Variables and Measurement

In this section, we describe how we measure our main dependent variable of interest, namely price delegation, and our main explanatory variables, which include the commission rate – treated as exogenous (predetermined) in some, and endogenous in other, analyses, as described in the next section – as well as tenure, customer heterogeneity, and agent skill. While some of our measures are cardinal (e.g., the extent of delegation, tenure), others are ordinal, obtained using 7-point items (e.g., customer heterogeneity and agent skill). See Table 1 for detailed descriptions of all the variables used in our analyses.

<<COMP: Place Table 1 about here>>

Price Delegation ($\frac{v_H - p_L}{v_H}$): Each manager was asked to report the percentage of price discount off the list price that the sales person is allowed to offer customers *without* conferring with his manager. Hence, higher percentages mean that the sales person has more discretion when making price offers to customers.[20] Our measure of delegation is cardinal, as opposed to the perceptual or ordinal measures that have been used in prior studies (e.g., Wulf, 2007; Nagar, 2002; Foss and Laursen, 2005; Hansen et al., 2008; DeVaro and Kurtulus, 2010; Frenzen et al., 2010). In addition, in this literature, a greater level of delegation is interpreted to mean a greater number of tasks being delegated. In our model as in our empirical implementation, more delegation takes the form of greater authority on a single task, namely that of choosing price. Figure 1 shows that there is substantial variation in the amount of pricing authority afforded sales people in our data.

<<COMP: Place Figure 1 about here>>

Compensation: For each sales person, we obtained measures of their salary and total compensation in the year prior to the survey, as well as the sales they generated during that year. *Base Salary* is the dollar amount of fixed compensation received by the sales person while *Total Compensation* refers to the sum of the base salary and performance-based compensation (e.g., bonus and commission pay) received in the last fiscal year. In our data, the proportion of performance-based to total compensation is about 30%, similar to the 29% ratio in John and Weitz (1989), but somewhat lower than Zoltner et al. (2006: 2)'s estimate of around 40% for a typical sales person in the U.S.

We calculate the commission rate (α) as:

Commission Rate = (Total Compensation – Base Salary)/Sales Revenue

where, *Sales Revenue* is the amount of sales generated by the sales person in the same fiscal year, also in US dollars.[21] In the presence of bonuses or other commission pay that would not be sales based (e.g., payments based on the number of newly acquired customers), our measure would overestimate the true marginal incentives. If bonuses are paid for achieving particular sales quotas, on the other hand, our measure has the advantage of capturing the average contribution of increased sales on the expected amount of bonuses paid. Since managers indicated that sales-based commission payments comprise the vast majority of their sales force's incentive pay, with bonuses representing at most 5% of total pay, we view our measure of *Commission Rate* as a good first-order approximation for sales-based performance pay.[22] We briefly revisit these measurement issues in discussing the robustness of our results in Section 5.

Sales Person's Tenure (t): We have information on the number of years (t) that the particular sales person has worked with the company. In our model, longer tenure leads to more delegation and, indirectly, a greater commission rate when the latter is endogenized.

Sales Person's Skill (β): Our theory predicts that higher agent skill will lead to more price delegation. We measure agent skill by asking his manager to rate the sales person's competence in tailoring his approach to specific customers and situations at hand.

Customer Heterogeneity (δ): We use a 7-point item to measure the heterogeneity of the firm's customers' needs (*Customer Heterogeneity*). Our model implies this is likely to have a positive effect on price delegation. Though our theoretical model does not explicitly include the difficulty in monitoring the sales person's activities (*Monitoring*

Difficulty), we inquired about this in our questionnaire and control for it in our regressions. Hubbard (2000) and Acemoglu et al. (2007) both suggest that the greater difficulty in monitoring the activities or inputs of the agent should lead to more delegation. In our model, greater monitoring difficulty might be related to the factors that make the agent more useful to the firm when it comes to understanding the customer's willingness to pay. Thus customer heterogeneity and monitoring difficulty might both capture different aspects of the informational advantage of the sales person over the firm.

Environmental Uncertainty (μ): Our model predicts that higher environmental uncertainty reduces the agent's informational advantage and hence the extent of price delegation given to the agent. Two survey items provide ordinal measures of such uncertainty: (i) uncertainty arising from the pace of product or equipment obsolescence (*Rapid Technological Change*) and (ii) uncertainty associated with product demand at the industry level (*Industry Demand Uncertainty*).

In addition to the variables above, we control for a number of other characteristics of the firm and agent in all our analyses. In particular, we include *Firm Size*, measured by sales revenues in the previous year, and *Firm Reputation*, measured via a 7-point item on the quality of the firm's products and services. Respondents also told us how many direct competitors they face in the relevant product category (*Number of Competitors*). Moreover, as described in our model, the commission rate is related to another characteristic of the sales agents, namely how distasteful variable compensation is to them (γ). We again obtained this information through our survey of those managers who

supervise the sales personnel. In all our regressions, we further control for industry fixed effects (SIC dummy variables).

As mentioned above, the specific questions or survey items used to elicit all the above data are listed in Table 1. Summary statistics for all the variables are shown in Table 2. Note that while our descriptive statistics are all in levels, in our regressions below, we use the (natural) log of *Tenure* and *Firm Size* to reduce the effect of outliers.

<<COMP: Place Table 2 about here>>

5. EMPIRICAL SPECIFICATION AND RESULTS

5.1. Econometric Specification

Our goal is to examine the determinants of the extent of delegation of pricing authority and to assess the relationship between the delegation decision and the compensation scheme.

As described earlier, the compensation plan for sales persons is usually the same for all the individuals engaged in the same type of sales job within the firm. The delegation of pricing authority in industrial sales forces, in contrast, is more often conferred on sales people by their managers after an individual sales person has started his/her job, and modified when appropriate in the course of one's career within the firm. Proposition 1 was derived under the assumption that the compensation scheme is pre-determined when managers decide on the level of price delegation they want to grant their sales agents. We test this proposition by estimating the following price delegation equation: [23]

$$\textit{Price Delegation}_i = \beta_1 * \textit{Commission Rate}_i + \beta_2 * \textit{Customer Heterogeneity}_i + \beta_3 * \mathrm{Log}(\textit{Tenure}_i) + \beta_4 * \textit{Skill}_i + \beta_5 * \textit{Industry Demand}$$

$$Uncertainty_i + \beta_6 * Rapid\ Technological\ Change_i + X_i'b + \varepsilon_i, \quad (7)$$

where i denotes the sales person (and implicitly the firm, as we have data relating to one sales person per firm), and X_i is a vector of control variables, including SIC code fixed effects. In this equation, our model predicts that β_1 to β_4 will be positive (Proposition 1) whereas β_5 and β_6 will be negative (Corollary 1).

One concern one might have with estimating this relationship is that factors omitted from this equation might affect both the *Commission Rate* and the level of *Price Delegation*, leading to a biased coefficient on the *Commission Rate*. For example, if larger firms were to give more pricing authority to their sales agents and pay higher commission rates, the coefficient of *Commission Rate* would be biased upwards if we did not include firm size in the regression. For that reason, in estimating (7), we verify the robustness of our results using an increasing number of control variables (see Table 3).

While we believe that treating the *Commission Rate* as exogenous, and controlling for task and firm characteristics that might affect both *Commission* and *Price Delegation* by including them in the *Price Delegation* equation, should be a valid approach in our setting, it is also true that when firms decide on their compensation schemes at the sales-force level, they might take their expected or desired level of pricing delegation into account. Alternatively, there may be some remaining unobserved factors that affect both the *Commission Rate* and *Price Delegation*. An instrumental-variable (IV) approach to estimate the *Price Delegation* equation addresses both of these issues. We use *Sales Person's Risk Aversion* as the excluded instrument for *Commission Rate*. Our model, and

agency models more generally, imply that incentive pay should be negatively related to the agent's distaste for variable pay, or his risk aversion, thus making this variable a good predictor of the commission rate. However, in our model as in most theories of delegation, agent risk aversion does not directly affect the principal's pricing authority decision.

Finally, in our model, tenure can serve as an instrument for *Price Delegation* as it does not directly affect the *Commission Rate*. Given this, in Appendix B, we show results from estimating our system of equations using 3SLS, with risk aversion again as the (excluded from the *Price Delegation* equation) instrument for the *Commission Rate*, and agent tenure as the excluded (from the *Commission Rate* equation) instrument for *Price Delegation*.

5.2. Results

Table 3 shows results from estimating equation (7) using OLS. In column 1, we include only the *Commission Rate* and the five main variables of interest, i.e., *Customer Heterogeneity*, *Tenure, Sales Person's Skill*, *Industry Demand Uncertainty*, and *Rapid Technological Change.* In column 2, we add *Base Salary*. Last, in column 3, we include *Firm Size*, *Firm Reputation*, *Number of Competitors*, and *Monitoring Difficulty*.

<<COMP: Place Table 3 about here>>

Our results strongly support the predictions of our model. First, we find that the commission rate indeed is highly positively correlated with price delegation. Both the magnitude of the coefficient and its statistical significance are similar across specifications. We also find that *Tenure* has a robust and positive effect on price

delegation, and that price delegation is increasing in agent skill, as measured by their managers. The latter effect is not measured with enough precision to be statistically significant in the first two columns, but it becomes highly significant once we include all our control variables.

We also find that firms delegate more pricing authority to their sales people when customer needs are more heterogeneous (p-values in columns 1 and 2 are 0.08 and 0.11 respectively). In the last column of Table 3, the effect of customer heterogeneity becomes lower and statistically insignificant. This is driven in part by the relationship between our measures of monitoring costs and customer heterogeneity: firms in our data that say that customer values vary importantly also tend to say that it is costly to monitor their sales force.[24] More importantly, one interpretation of monitoring difficulty in our industrial sales setting is that, if the agent asks for permission for a price cut, *Monitoring Difficulty* captures how difficult it is to verify whether such a price cut is justified based on agent activities. For parsimony, we have not formally modeled this process, but it is reasonable to assume that when supervising the agent's input activities is difficult, the agent has an informational advantage regarding pricing decisions such that the firm will find it profitable to delegate this decision to a greater extent.[25] In that sense, *Monitoring Difficulty* captures another dimension of the informational advantage of the agent, in which case our model predicts that it should have a positive effect on price delegation as well.

While the coefficients are not always statistically significant, we find that both our measures of environmental uncertainty have a negative effect on price delegation, as

implied by Corollary 1. This contrasts with results in the empirical literature testing the prediction from Prendergast (2002) and Acemoglu et al. (2007) that settings with greater uncertainty should be associated with greater levels of delegation. Contrary to the contexts of these studies where the knowledge of unknown (or uncertain) market environments can be endogenously resolved by the agent exerting more effort (Prendergast, 2002), however, our measures capture a type of uncertainty that agents cannot act to reduce (Lafontaine and Bhattacharyya, 1995; Shi, 2011). Per Corollary 1, the agent's informational advantage is reduced by such environmental uncertainty, leading the firm to give less pricing flexibility to the agent.[26]

The fact that some of our control variables are strongly associated with price delegation suggests that it is indeed important to include them in our regressions. In particular, consistent with our interviewees' contention that competition forces the firm to improve the sales person's responsiveness to customer-specific conditions, and thus increase the pricing authority it gives the agent, we find a large positive effect of the *Number of Competitors* on price delegation. In our model, the private (or local) information of the agent concerns customer valuations, and the agent is given discretion to make use of this information to price better. An alternative model could be constructed in which the agent's private information is about competing offers (and the value of those to the customer). Again, giving more discretion would allow the agent to make better use of this information to counter competing offers when needed. Consistent with our empirical results, more competition would make pricing discretion more valuable in these models.

Our findings also are consistent with those in Bloom, Sadun and Van Reenen (2010) who find that tougher competition is associated with a greater delegation of decision-making authority from central headquarters to local plant managers. They conjecture that tougher competition makes local managers' information more valuable, as delays to decisions become more costly. Costly delays are also a plausible mechanism in our setting. Indeed, a higher pricing floor may result in more delays, since the sales agent then needs to ask more frequently for permission to give a price discount. Another suggested mechanism in the literature is that competition reduces agency problems. While we see no reason why competition would align the incentives of the sales agent in our setting, our data do not allow us to rule out this mechanism. Aghion, Bloom, and Van Reenen (2014, Section 3.4.4) provide an in-depth discussion of the empirical literature on the correlation between competition and delegation.

Finally, when we control for firm characteristics in column 3, only those firms in SIC 36 employ a statistically different level of delegation. *Firm Reputation* and *Firm Size* moreover do not appear to affect the level of delegation directly. Presumably, this is because regardless of size or reputation differences, these firms are engaged in similarly complex selling processes and as such, must address similar issues in deciding the level of price delegation they grant to their sales people.

Results from estimating equation (7) for the same set of specifications as in Table 3, but using an instrumental variable (2SLS) approach where we treat the commission rate as endogenous, are summarized in Tables 4A and 4B. Specifically, in Table 4A, we show

results for the *Price Delegation* equation. We show the first-stage regression results, for the *Commission Rate*, in Table 4B.

<<COMP: Place Table 4A about here>>

<<COMP: Place Table 4B about here>>

Results in Table 4A again are quite consistent across specifications, and similar to those in Table 3, where we assumed the commission rate was pre-determined. First, the effect of the *Commission Rate* on *Price Delegation* remains positive and statistically significant across all specifications. The lowest coefficient, of 2.87 in column 3, implies that an increase of one percentage point in the commission rate (from say 3 percent to 4 percent) leads to an increase of 2.87 percentage points in the maximum price discount (from say 10% off the list price to 12.87%) that a sales person can offer his/her customers. These are economically important effects, given the high value of industrial equipment: the average sales person in our data generates revenues of $1.7M (see Table 2), so a price reduction of about 3% represents a discount of about $50,000. Second, and again consistent with the predictions of our model (Proposition 1) and results in Table 3, *Sales Person's Tenure* – a measure of the competence of the sales person, which can be attributed to selection and experience – has a large positive and statistically significant effect on price delegation. Specifically, the coefficient of 2.22 in column 3 means that each year of increased tenure is associated with a 0.55 percentage point increase in the allowed reduction off the list price for a typical sales person in our sample (note that average *Tenure* is 4.07 years).[27] Similarly, price delegation is increasing in *Sales Person's Skill,* and this effect is statistically significant in Column 3, where we use our

full set of control variables. Finally, *Customer Heterogeneity* still has a positive effect on the extent of price delegation, although this effect is no longer measured with enough precision to be statistically significant. As in Table 3, removing *Monitoring Difficulty* from the regression makes the coefficient of *Customer Heterogeneity* more significant (p-value = 0.11 in column 3).

At the bottom of Table 4A, we report the partial F-statistics for the first-stage regressions. These range from 20.50 to 42.69, much larger than Staiger and Stock (1997)'s suggested value of 10, thereby confirming that *Risk Aversion* is a strong instrument for the *Commission Rate*. Tests of the endogeneity of the *Commission Rate*, namely Wooldridge's (1995) score diagnostic for 2SLS, also shown at the bottom of Table 4A, indicate that the null hypothesis that the *Commission Rate* is exogenous cannot be rejected at the 10% significance level in any of the regressions. In fact, when we include the full set of control variables in column 3, the potential correlation between *Commission Rate* and the error term that would bias the coefficient of *Commission Rate* is basically completely eliminated, and, consistent with this, the effect of the commission rate is quite similar across the two tables in this case.

Results for our control variables in Table 4A are very similar to those discussed above for Table 3. We therefore turn to Table 4B, which shows the first-stage results. Per Wooldridge (2010: 96-97), the coefficients of the exogenous variables in Table 4B can be interpreted as reduced-form effects corresponding to the predictions in Proposition 2 and Corollary 2 above for the commission rate.

As one would expect from our model, but also more generally from both theory and empirical analyses of performance pay schemes (e.g., Lo et al., 2011; DeVaro and Prasad, 2013), we first find that the commission rates are associated with several job and agent characteristics. Supporting Proposition 2, more risk-averse agents work under lower-powered compensation schemes, whereas those who are perceived as more skillful work under higher-powered compensation schemes on average. Lo et al. (2011) argue that the latter result obtains because agents self-select into jobs and compensation schemes that fit their characteristics. Consistent with the fact that the positive effect of tenure on the commission rate stated in Proposition 2 operates only via the effect of tenure on price delegation, and consistent with industry practice, we find that *Sales Person's Tenure* does not affect the commission rate directly. Customer heterogeneity, whose effect on the commission rate is somewhat ambiguous but likely positive in theory, indeed has a positive effect that is also statistically significant when we include all our control variables in column 3 of Table 4B. Finally, the coefficients of our two measures of environmental uncertainty – *Rapid Technological Change* and *Industry Demand Uncertainty* – are negative, as expected per Corollary 2, but they are small and not measured with enough precision to be statistically significant.

As for the effects of control variables in Table 4B, we first confirm that firms trade off base salary and the commission rate, as predicted by most agency models and in particular models of sales force compensation. It is reassuring to find this effect in our cross-sectional setting. Second, firms operating in environments with greater numbers of competitors offer a slightly higher commission rate, probably aiming to induce higher

levels of sales effort and better align the interests of the agent with those of the firm. Third, larger firms also offer higher commission rates. This may be a monitoring issue, or related to the well-known firm-size effect on pay (e.g., Brown and Medoff, 1989). Fourth, firms with a reputation for higher quality products tend to rely less on commission pay, presumably because agent effort is less important for them. Fifth, we find that the coefficient of *Monitoring Difficulty* is small and not statistically significant. Indeed, instead of increasing their reliance on incentive pay, we see firms addressing issues of monitoring costs by giving greater pricing authority to their agents. Finally, when we control for firm size and reputation, only the fixed effect for SIC 36 is significant, suggesting again that the majority of the firms in our sample face similar challenges when it comes to their sales forces, despite being classified in different industrial sectors.

We conducted a number of robustness analyses to further confirm the results above. First, we verified that our results remain basically unchanged when we estimate them using 3SLS, as described at the end of Section 4. The results, in Appendix B, are indeed very similar. For the delegation equation, the coefficients are identical to those in Table 4A as 3SLS estimation yields only more efficient estimates for this equation than 2SLS does. None of the differences in standard errors, however, affect our conclusions. Moreover, results for the commission rate regression in Appendix B show no effect of delegation on the commission rate. It is therefore not surprising that the conclusions above remain valid here as well.

In addition, we carried out robustness analyses to address (i) issues of functional form and (ii) the possibility that our measure of commission rate overstates the true marginal incentives of the agents because the variable component of pay in our data might include some (limited) bonus payments. Results remained qualitatively equivalent when we used the log of price delegation rather than its level as our dependent variable, or when we used the log of both *Price Delegation* and *Commission Rate*.[28] Median regressions, which may help alleviate the effect of outliers, also yielded qualitatively equivalent results. Similarly, our results were unaffected when we measured the commission rate as the remainder of variable pay over revenues after removing either 2.5% or 5% of the sales people's total compensation, under the assumption that this part of the variable pay might represent bonuses. We chose these portions of pay to remove as managers indicated that 5% would probably be the largest amount of bonus pay these sales people would get.

6. CONCLUSION

Despite considerable theoretical interest and recent empirical work on delegation or decision-rights allocation and on its relationship with incentive pay, empirical analyses regarding these remain lacking. In this paper, we first developed a theoretical model to explain a particular type of delegation, namely the pricing flexibility afforded to sales people, and its relationship with commission rates in the context of industrial equipment sales, using several distinguishing features of this empirical setting to guide our modeling assumptions. We then tested the implications of our model in terms of both the determinants of the pricing flexibility or price delegation given to sales people by their

business-unit or divisional managers, and the relationship between the intensity of incentives in their compensation scheme and the extent of price delegation.

In our data, we found strong support for the predictions of our model. In particular, sales people are given more pricing authority when they have been with the firm longer and when their sales managers consider them to be more highly skilled. We also find that firms offer more pricing authority to their sales agents when they face more heterogeneous customers, which increases the value of the sales person's information, though this effect is not always statistically significant. In contrast, our data show that firms give less pricing authority when the environment is more uncertain, as our model also predicts, given that this type of uncertainty reduces the informational advantage of the agent. Most importantly, we find that pay-for-performance, or the commission rate, affects price delegation positively.

While consistent with the implications of our model, our key empirical results are also consistent with Prendergast's (2002) model of delegation and incentive provision and related empirical literature. However, since commission rates are not tailored to the individual in our setting, while price delegation is, the decision process is different from that assumed by Prendergast, whose model may be better suited to the study of executive compensation, for example. Nonetheless, the positive effect of incentives on delegation that we document is consistent with his model – and with results in, e.g., Foss and Laursen (2005), Ben-Ner et al. (2012), and DeVaro and Kurtulus (2010), whose empirical analyses examine predictions from his model – in that we show that these decisions are interconnected. However, the lack of effect of price delegation in the commission rate

regression when we estimate these simultaneously, and the negative effect of environmental uncertainty on delegation, confirm other implications of our model and suggest that the framework we use is preferable in the particular context we study.

This idea, that compensation scheme and delegation are fundamentally related decisions, can be traced back at least to Jensen and Meckling (1976) (see also Brickley et al., 2009, Chapter 11), and we view our empirical results as supportive not only of our model, but also of this general class of arguments. A major advantage of our study is that the context of industrial sales provides clear measures of delegation and incentive provision. In other contexts, companies often delegate decisions along multiple dimensions (e.g., product decisions, customer selection, and pricing) and offer incentives with several components (e.g., bonus and promotion in additional to commissions and fixed salary). Understanding the details of how these interact in more complex contexts is, in our view, a promising avenue for future research.

Appendix A

Details of derivations

The first-order condition for the principal's maximization problem is

$$\frac{\partial \Pi_{\mathrm{P}}}{\partial p_L} = -\frac{q^* p_L}{v_H - v_L} + \left(\frac{v_H^2 - p_L^2}{2(v_H - v_L)}\right)\frac{\partial q^*}{\partial p_L} - q^*\left(\frac{-c}{v_H - v_L}\right) - c\left(\frac{v_H - p_L}{v_H - v_L}\right)\frac{\partial q^*}{\partial p_L} + \left[\frac{-(p_L - c)}{v_H - v_L} + \right.$$

$$\left.\left(\frac{v_H - p_L}{v_H - v_L}\right) - q^*\frac{-(p_L - c)}{v_H - v_L} + q^*\left(\frac{v_H - p_L}{v_H - v_L}\right) - (p_L - c)\left(\frac{v_H - p_L}{v_H - v_L}\right)\frac{\partial q^*}{\partial p_L}\right)\Bigg] - ke^*\frac{\partial e^*}{\partial p_L} = 0,$$

which can be simplified to:

$$\frac{(1-q^*)(v_H - p_L)}{v_H - v_L} - \frac{p_L - c}{v_H - v_L} + \frac{(v_H - p_L)^2}{2(v_H - v_L)}\frac{\partial q^*}{\partial p_L} - ke^*\frac{\partial e^*}{\partial p_L} = 0.$$

Substituting $e^* = \frac{\beta\alpha}{2k}\frac{(v_H - p_L)^2}{v_H - v_L}$ and $\frac{\partial q^*}{\partial p_L} = \beta\frac{\partial e^*}{\partial p_L}$ and rearranging terms, we obtain

$$\frac{\partial \Pi_P}{\partial p_L} = \frac{(1-q^*)(v_H - p_L)}{v_H - v_L} - \frac{p_L - c}{v_H - v_L} + (1-\alpha)\beta\frac{\partial e^*}{\partial p_L}\frac{(v_H - p_L)^2}{2(v_H - v_L)} = 0,$$

which is equivalent to condition (2) in the main text. By substituting $\frac{\partial e^*}{\partial p_L} = \frac{-\beta\alpha(v_H - p_L)}{k(v_H - v_L)}$ and differentiating with respect to p_L, we obtain the following second-order condition

$$\frac{\partial^2 \Pi_P}{\partial p_L^2} = -\frac{(2-q^*)}{v_H - v_L} + (1-\alpha)\frac{\beta^2\alpha}{k(v_H - v_L)}\frac{3(v_H - p_L)^2}{2(v_H - v_L)} < 0.$$

which is equivalent to equation (3) in the text. Since $p_L \geq v_L$ and $q^* < 1$ we obtain the sufficient condition (4) after some manipulations.

Proof of Proposition 1: Define D from the left-hand side of (2)

$$D \equiv (1-q^*)(v_H - p_L) - (p_L - c) + \frac{1}{2}(1-\alpha)\beta(v_H - p_L)^2\frac{\partial e^*}{\partial p_L} \qquad \text{(A1)}$$

$$= (1-t)(v_H - p_L) - (p_L - c) - (2-\alpha)\frac{\beta^2\alpha}{2k}\frac{(v_H-p_L)^3}{v_H-v_L}.$$

From the first-order condition, $D = 0$ at $p_L = p_L^*$. Deriving implicitly, for the exogenous variables $x \in \{\alpha, t, \beta\}$

$$\frac{\partial D}{\partial p_L}\frac{dp_L}{dx} + \frac{\partial D}{\partial x} = 0$$

and, hence

$$\frac{dp_L^*}{dx} = -\frac{\partial D}{\partial x} \Big/ \frac{\partial D}{\partial p_L}.$$

From the second-order condition, we have $\frac{\partial D}{\partial p_L} < 0$ at $p_L = p_L^*$. Using (A1), one can further verify that

$$\frac{\partial D}{\partial \alpha} = -\frac{(1-\alpha)\beta^2(v_H-p_L)^3}{k(v_H-v_L)} < 0,$$

$$\frac{\partial D}{\partial t} = -(v_H - p_L) < 0,$$

and

$$\frac{\partial D}{\partial \beta} = -\frac{(2-\alpha)\alpha\beta(v_H-p_L)^3}{k(v_H-v_L)} < 0.$$

Hence, we have $\frac{dp_L^*}{d\alpha} < 0$, $\frac{dp_L^*}{dt} < 0$, and $\frac{dp_L^*}{d\beta} < 0$. QED.

Appendix B

<<COMP: Place Table B1 about here>>

<<COMP: Place Table B2 about here>>

References

Abernethy, Margaret, Jan Bouwens, and Laurene van Lent. 2004. "Determinants of Control System Design in Divisionalized Firms," 79 *The Accounting Review* 545-570.

Acemoglu, Daron, Philippe Aghion, Claire Lelarge, John Van Reenen, and Fabrizio Zilibotti. 2007. "Technology, Information, and the Decentralization of the Firm," 122 *Quarterly Journal of Economics* 1759-1799.

Aggarwal, Rajesh K., and Andrew A. Samwick. 1999. "The Other Side of the Trade-off: The Impact of Risk on Executive Compensation," 107 *Journal of Political Economy* 65-105.

Aghion, Philippe, Nicholas Bloom, and John van Reenen. 2014. "Incomplete Contracts and the Internal Organization of Firms," 30 *Journal of Law, Economics, & Organization* 37-63.

Aghion, Philippe, and Tirole, Jean. 1997. "Formal and Real Authority in Organizations," 105 *Journal of Political Economy* 1-27.

Albers, Sonke. 1996. "Optimization Models of Salesforce Compensation," 89 *European Journal of Operational Research* 1-17.

Alonso, Ricardo, and Niko Matouschek. 2007. "Optimal Delegation," 75 *Review of Economic Studies* 259-293.

Alonso, Ricardo, Wouter Dessein, and Niko Matouschek. 2008. "When Does Coordination Require Centralization?" 98 *American Economic Review* 145-179.

Alonso, Ricardo, Wouter Dessein, and Niko Matouschek. 2015. "Organizing to Adapt and Compete," 7 *American Economic Journal: Microeconomics* 158-187.

Anderson, Erin, and David C. Schmittlein. 1984. "Integration of Sales Force: An Empirical Examination," 15 *Rand Journal of Economics* 385-395.

Arrunãda, Benito, Luis Garicano, and Luis Vázquez. 2001. "Contractual Allocation of Decision Rights and Incentives: The Case of Automobile Distribution," 17 *Journal of Law, Economics, & Organization* 257-284.

Baker, George, Robert Gibbons, and Kevin Murphy. 1999. "Informal Authority in Organizations," 15 *Journal of Law, Economics, & Organization* 56-73.

Ben-Ner, Avner, Fanmin Kong, and Stephanie Lluis. 2012. "Uncertainty, Task Environment, and Organization Design: An Empirical Investigation," 82 *Journal of Economic Behavior & Organization* 281-313

Bloom, Nicholas, Raffaella Sadun, and John van Reenen. 2010. "Does Product Market Competition Lead Firms to Decentralize?" Working paper. Rock Center for Corporate Governance, Stanford University.

Brickley, James A., Clifford W. Smith, and Jerold L. Zimmerman. 2009. *Managerial Economics and Organizational Architecture*. New York, NY: McGraw-Hill/Irwin.

Brown, Charles, and James Medoff. 1989. "The Employer Size-Wage Effect," 97 *Journal of Political Economy* 1027-1059.

Dalijord, Oystein, Sanjor Misra, and Harikesh S. Nair. 2014. "Homogenous Contracts for Heterogeneous Agents: Aligning Salesforce Composition and Compensation," Working paper, Stanford University.

Dessein, Wouter. 2002. "Authority and Communications in Organizations," 69 *Review of Economic Studies* 811-838.

DeVaro, Jed and Fidan Ana Kurtulus. 2010. "An Empirical Analysis of Risk, Incentives and the Delegation of Worker Authority," 63 *Industrial and Labor Relations Review* 641-661.

De Varo, Jed and Suraj Prasad. 2013. "The Relationship Between Delegation and Incentives Across Occupations: Evidence and Theory," Working paper, California State University at East Bay.

Foss, Nicholai and Keld Laursen. 2005. "Performance Pay, Delegation, and Multitasking under Uncertainty and Innovativeness: An Empirical Investigation," 58 *Journal of Economic Behavior & Organization* 246-276.

Frenzen, Heiko, Ann-Kristin Hansen, Manfred Krafft, Murali K. Mantrala, and Simone Schmidt. 2010. "Delegation of Pricing Authority to the Sales Force: An Agency-Theoretic Perspective of its Determinants and Impact on Performance," 27 *International Journal of Research in Marketing* 58-68.

Graham, John R., Campbell R. Harvey, and Manju Puri. 2013. "Capital Allocation and Delegation of Decision-Making Authority within Firms," Working paper #1571527, SSRN.

Hansen, Ann-Kristin, Kissan Joseph, and Manfred Krafft. 2008. "Price Delegation in Sales Organizations: An Empirical Investigation," 1 *Business Research* 94-104.

Holmstrom, Bengt. 1977. *On Incentives and Control in Organizations*, Ph.D. dissertation. Stanford University.

Holmstrom, Bengt. 1984. "On the Theory of Delegation," in Marcel Boyer and Richard Kihlstrom, eds., *Bayesian Models in Economic Theory.* New York, NY: Elsevier.

Hubbard, Thomas. 2000. "The Demand for Monitoring Technologies: The Case of Trucking," 115 *Quarterly Journal of Economics* 533-560.

Jensen, Michael, and William Meckling. 1976. "Theory of the Firm: Managerial Behavior, Agency Costs, and Capital Structure," 3 *Journal of Financial Economics* 305-360.

Jensen, Michael, and William Meckling. 1992. "Specific and General Knowledge, and Organizational Structure," in Lars Werin and Hans Wijkander, eds., *Contract Economics.* Cambridge, MA: Basil Black.

John, George, and Barton Weitz. 1989. "Sales force Compensation: An Empirical Investigation of Factors Related to Use of Salary Versus Incentive Compensation," 26 *Journal of Marketing Research* 1-14.

Joseph, Kissan. 2001. "On the Optimality of Delegating Pricing Authority to the Sales Force," 65 *Journal of Marketing* 62-70.

Joseph, Kissan, and Manohar Kalwani. 1998. "The Role of Bonus Pay in Salesforce Compensation Plans," 27 *Industrial Marketing Management* 147-159.

Kato, Takao, and Motohiro Morishima. 2002. "The Productivity Effects of Participatory Employment Practices: Evidence from New Japanese Panel Data," 41 *Industrial Relations* 487-520.

Lafontaine, Francine, and Sugato Bhattacharyya. 1995. "The Role of Risk in Franchising," 2 *Journal of Corporate Finance* 39-74.

Lafontaine, Francine and Margaret E. Slade. 1996. "Retail Contracting and Costly Monitoring: Theory and Evidence," 40 *European Economic Review* 923-932.

Lal, Rajiv. 1986. "Delegating Pricing Responsibility to the Sales Force," 5 Marketing Science 159-168.

Lal, Rajiv, and V. Srinivasan. 1993. "Compensation Plans for Single- and Multi-Product Salesforce: An Application of the Holmstrom-Milgrom Model," 39 *Management Science* 777-793.

Larkin, Ian. 2014. "The Cost of High-Powered Incentives: Employee Gaming in Enterprise Software Sales," *Journal of Labor Economics* 199-227.

Lazear, Edward P. 2000. "Performance Pay and Productivity," 90 *American Economic Review* 1346-1361.

Lo, Desmond, Mrinal Ghosh, and Francine Lafontaine. 2011. "The Incentive and Selection Roles of Sales Force Compensation Contracts," 48 *Journal of Marketing Research* 781-798.

MacLeod, Bentley and Daniel Parent. 1999. "Job Characteristics and the Form of Compensation," 18 *Research in Labor Economics* 177-242.

McElheran, Kristina S. 2014. "Delegation in Multi-Establishment Firms: Adaptation vs. Coordination in I.T. Purchasing," 23 *Journal of Economics & Management Strategy* 225-258.

Mishra, Birendra, and Ashutosh Prasad. 2004. "Centralized Pricing Versus Delegating Pricing to the Salesforce under Information Asymmetry," 23 *Marketing Science* 21-27.

Misra, Sanjog, and Harikesh Nair. 2011. "A Structural Model of Sales-Force Compensation Dynamics: Estimation and Field Implementation," 9 *Quantitative Marketing and Economics* 211-257.

Nagar, Venky. 2002. "Delegation and Incentive Compensation," 77 *The Accounting Review* 379-395.

Oyer, Paul. 1998. "Fiscal Year Ends and Nonlinear Incentive Contracts: The Effect on Business Seasonality," 113 *Quarterly Journal of Economics* 149-185.

Oyer, Paul. 2000. "A Theory of Sales Quotas with Limited Liability and Rent Sharing," 18 *Journal of Labor Economics* 405-425.

Prendergast, Canice. 2002. "The Tenuous Trade-Off between Risk and Incentives," 110 *Journal of Political Economy* 1071-1102.

Rajan, Raghuram, and Julie Wulf. 2006. "The Flattening Firm: Evidence from Panel Data on the Changing Nature of Corporate Hierarchies," 88 *Review of Economic Studies* 759-73.

Shi, Lan. 2011. "Respondable Risk and Incentives for CEOs: The Role of Information-Collection and Decision-Making," 17 *Journal of Corporate Finance* 189-205.

Staiger, Douglas, and James H. Stock. 1997. "Instrumental Variables Regression with Weak Instruments," 65 *Econometrica* 557-586.

Thomas, Catherine. 2010. "Too Many Products: Decentralized Decision-Making in Multinational Firms," 3 *American Economic Journal: Microeconomics* 280-306.

Williamson, Oliver. 1985. *The Economic Institutions of Capitalism.* New York, NY: Free Press.

Wooldridge, Jeffrey M. 1995. "Score diagnostics for linear models estimated by two stage least squares," in G. S. Maddala, P. C. B. Phillips, and T. N. Srinivasan, eds., *Advances in Econometrics and Quantitative Economics: Essays in Honor of Professor C. R. Rao*. Oxford: Blackwell.

Wooldridge, Jeffrey M. 2010. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: the MIT Press.

Wulf, Julie. 2007. "Authority, Risk, and Performance Incentives: Evidence from Division Manager Positions Inside Firms," 55 *Journal of Industrial Economics*169-196.

Zoltners, Andris A., Prabhakant Sinha, and Sally E. Lorimer. 2006.*The Complete Guide to Sales Force Incentive Compensation: How to Design and Implement Plans that Work.* New York, NY: AMACOM.

FIGURE 1: THE EXTENT OF PRICING DELEGATION

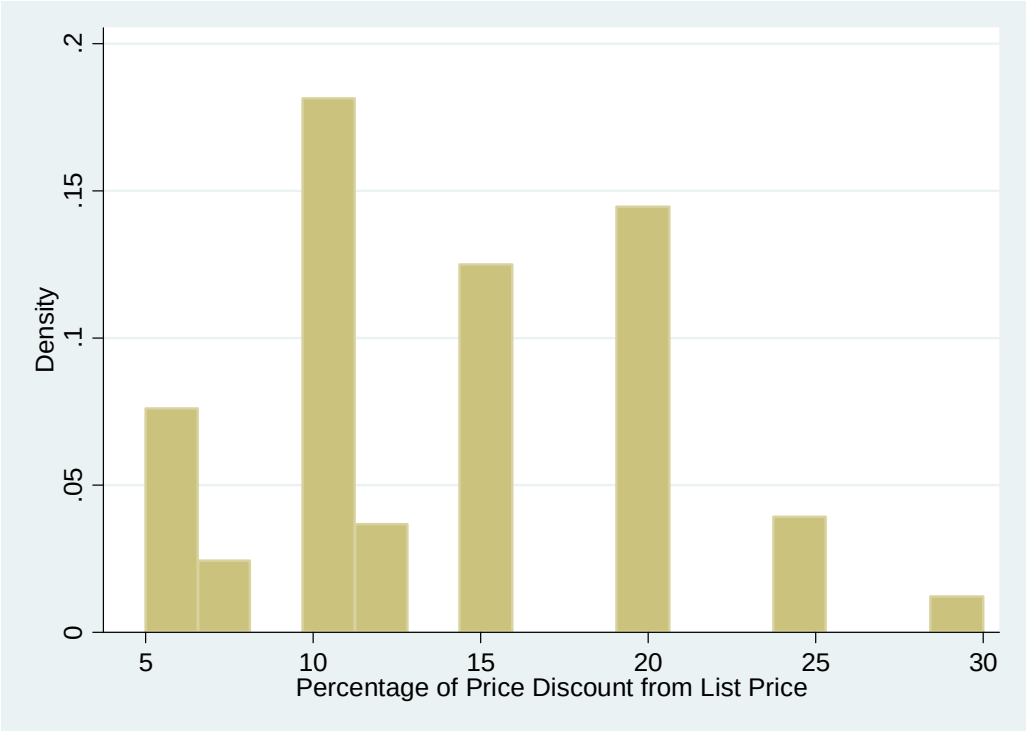

TABLE 1: DESCRIPTION OF VARIABLES

Price Delegation	This sales person has authority to offer customers price discounts of up to ___ % off the list price without conferring with his/her supervisors.
Sales Person's Tenure	Number of years this sales person has been working in your company.
Sales Person's Skill†	This sales person has a high degree of competence in tailoring his/her sales approach to the specific situation on hand.
Customer Heterogeneity†	Our product can be used in manufacturing / administrative / operational activities that vary widely from customer to customer.
Number of Competitors	What is the number of competitors for this product-line/equipment?
Firm Size	Total firm or strategic business unit revenues for the year (sales revenue in US dollar millions)
Firm Reputation†	Our company has a good standing in the business world for providing quality products and services.
Monitoring Difficulty†	It is not possible to supervise the sales person's activities closely.
Rapid Technological	The machine/equipment in this product category becomes

Change†	obsolete very fast.
Industry Demand Uncertainty†	The total demand in this product category is very predictable (reverse coded).
Sales Person's Risk Aversion†	In my opinion, this sales person would be willing to sacrifice some "top-end" variable pay to assure himself/herself of a steady compensation (i.e. base salary).
Base Salary	What was the total fixed compensation (i.e. base salary) that was received by this sales person in the last fiscal year?
Total Compensation	What was the total compensation (base salary plus performance based compensation - commissions, quotas etc.- that is based on a fixed formulae) received by this sales person in the last fiscal year?
Sales Generated by Sales Person	What was the total revenue, in million US dollars, generated by this sales person in the last fiscal year?
Commission Rate	*(Total Compensation – Base Salary)/(Sales Generated by Sales Person)*

†Measured using a 7-point scale (1= totally disagree; 7= totally agree).

TABLE 2: DESCRIPTIVE STATISTICS

Variables	Mean	Std. Dev.	Min.	Max.
Price Delegation	13.98	6.05	5	30
Sales Person's Tenure[#]	4.07	2.66	1	15
Sales Person's Skill	4.70	1.32	2	7
Customer Heterogeneity	3.67	1.55	1	7
Number of Competitors	8.96	4.84	2	40
Firm Size[#] **	1627.7	5915.5	102	83,000
Firm Reputation	4.18	1.49	1	7
Rapid Technological Change	3.64	1.57	1	7
Industry Demand Uncertainty	3.36	1.45	1	7
Monitoring Difficulty	3.75	1.24	1	6
Sales Person's Risk Aversion	3.36	1.28	1	7
*Base Salary**	82.6	15.6	52.5	118.5
*Total Compensation**	117.0	21.7	73	170
*Sales Generated by Sales Person**	1707.2	1848.3	580	24,000
Commission Rate	2.39	0.97	0	5.16

[#] Summary statistics are in levels. In our empirical analyses, we use the log of these variables.

* In thousands of dollars.

** In millions of dollars.

Number of observations = 261. Each firm represents one sales person in our data.

TABLE 3: DETERMINANTS OF PRICE DELEGATION

(OLS regressions: Commission Rate is treated as pre-determined)

Dependent Variable: *Price Delegation*

	(1)	(2)	(3)
Main Variables			
Commission Rate	2.63***	2.96***	2.46***
	(0.34)	(0.32)	(0.39)
Log(*Sales Person's Tenure*)	1.94***	2.12***	2.16***
	(0.46)	(0.46)	(0.52)
Sales Person's Skill	0.39	0.38	0.67***
	(0.24)	(0.23)	(0.25)
Customer Heterogeneity	0.32*	0.30	0.17
	(0.18)	(0.19)	(0.17)
Industry Demand Uncertainty	-0.35	-0.24	-0.44**
	(0.23)	(0.21)	(0.19)
Rapid Technological Change	-0.72***	-0.63***	-0.88***
	(0.23)	(0.22)	(0.20)
Control Variables			
Base Salary		0.06**	0.06**
		(0.02)	(0.02)
Number of Competitors			0.30***

			(0.07)
Log(*Firm Size*)			0.29
			(0.32)
Firm Reputation			-0.40
			(0.26)
Monitoring Difficulty			1.02***
			(0.26)
SIC36	1.51*	1.32	2.00**
	(0.87)	(0.87)	(0.86)
SIC37	-1.98**	-1.52*	-0.12
	(0.91)	(0.88)	(0.85)
SIC38	-1.46	-1.38	-0.47
	(1.00)	(0.98)	(0.90)
Constant	6.29***	0.01	-9.93
	(2.05)	(3.07)	(6.37)
R^2	0.33	0.35	0.46
F-statistic	23.43***	22.46***	17.50***

Number of observations = 261, with each firm providing a single observation, for a particular sales person.

* significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parentheses.

TABLE 4A: DETERMINANTS OF PRICE DELEGATION

(IV regressions: Commission Rate is treated as endogenous)

Dependent Variable: *Price Delegation*

	(1)	(2)	(3)
Main Variables			
Commission Rate	4.42***	4.51***	2.87**
	(1.07)	(1.11)	(1.43)
Log(*Sales Person's Tenure*)	1.93***	2.23***	2.22***
	(0.47)	(0.49)	(0.58)
Sales Person's Skill	0.11	0.16	0.59*
	(0.27)	(0.26)	(0.34)
Customer Heterogeneity	0.25	0.23	0.15
	(0.19)	(0.20)	(0.19)
Industry Demand Uncertainty	-0.36	-0.18	-0.41*
	(0.23)	(0.22)	(0.22)
Rapid Technological Change	-0.65***	-0.52**	-0.85***
	(0.22)	(0.21)	(0.21)
Control Variables			
Base Salary		0.09***	0.07
		(0.03)	(0.05)
Number of Competitors			0.29***
			(0.08)

Log(*Firm Size*)			0.21
			(0.44)
Firm Reputation			-0.34
			(0.35)
Monitoring Difficulty			1.05***
			(0.31)
SIC36	1.21	0.98	1.97**
	(0.92)	(0.90)	(0.82)
SIC37	-1.40	-0.81	0.08
	(0.97)	(1.01)	(1.11)
SIC38	-1.85*	-1.63*	-0.51
	(1.02)	(0.97)	(0.87)
Constant	3.46	-5.99	-10.33
	(2.66)	(5.24)	(6.37)
χ^2-statistic	137.52***	119.90***	229.66***
Partial F-statistic (H_0: instrument is weak)	42.69***	38.42***	20.50***
Robust score χ^2 statistic (H_0: commission rate is exogenous)	2.49	1.79	0.08

Estimated by 2SLS. Number of observations = 261, with each firm providing a single observation, for a particular sales person.

* significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parentheses.

TABLE 4B: FIRST-STAGE REGRESSIONS

Dependent Variable: *Commission Rate*

	(1)	(2)	(3)
Main Variables			
Sales Person's Risk Aversion	-0.21***	-0.21***	-0.15***
	(0.03)	(0.03)	(0.03)
Log(Sales Person's Tenure)	0.02	-0.05	-0.12
	(0.08)	(0.08)	(0.08)
Sales Person's Skill	0.13***	0.12***	0.16***
	(0.04)	(0.04)	(0.04)
Customer Heterogeneity	0.04	0.04	0.05*
	(0.03)	(0.03)	(0.03)
Industry Demand Uncertainty	0.03	-0.01	-0.05
	(0.05)	(0.04)	(0.04)
Rapid Technological Change	-0.01	-0.04	-0.05
	(0.04)	(0.04)	(0.04)
Control Variables			
Base Salary		-0.02***	-0.03***
		(0.00)	(0.00)
Number of Competitors			0.02*
			(0.01)
Log(*Firm Size*)			0.19***

			(0.06)
Firm Reputation			-0.10***
			(0.04)
Monitoring Difficulty			-0.08
			(0.05)
SIC36	0.12	0.17	0.06
	(0.15)	(0.15)	(0.15)
SIC37	-0.12	-0.26*	-0.33**
	(0.15)	(0.14)	(0.17)
SIC38	0.27*	0.21	0.12
	(0.16)	(0.15)	(0.14)
Constant	2.13***	4.38***	1.43
	(0.34)	(0.40)	(1.14)
F-statistic	10.11***	13.76***	11.44***

First-stage regressions for corresponding columns in Table 4A. Number of observations = 261, with each firm providing a single observation, for a particular sales person. * significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in parentheses.

TABLE B1: DETERMINANTS OF PRICE DELEGATION

(Estimated jointly with Table B2 by 3SLS)

	(1)	(2)	(3)
Main Variables			
Commission Rate	4.42***	4.51***	2.87*
	(1.27)	(1.26)	(1.65)
Log(Sales Person's Tenure)	1.93***	2.23***	2.22***
	(0.55)	(0.54)	(0.53)
Sales Person's Skill	0.11	0.16	0.59
	(0.32)	(0.30)	(0.39)
Customer Heterogeneity	0.25	0.23	0.15
	(0.23)	(0.22)	(0.21)
Industry Demand Uncertainty	-0.36	-0.18	-0.41*
	(0.25)	(0.25)	(0.25)
Rapid Technological Change	-0.65***	-0.52**	-0.85***
	(0.25)	(0.25)	(0.25)
Control Variables			
Base Salary		0.09***	0.07
		(0.04)	(0.05)
Number of Competitors			0.29***
			(0.08)
Log(Firm Size)			0.21

			(0.44)
Firm Reputation			-0.34
			(0.31)
Monitoring Difficulty			1.05***
			(0.31)
SIC36	1.21	0.98	1.97**
	(0.87)	(0.87)	(0.77)
SIC37	-1.40	-0.81	0.08
	(1.19)	(1.23)	(1.30)
SIC38	-1.85*	-1.63*	-0.51
	(0.97)	(0.93)	(0.84)
Constant	3.46	-5.99	-10.33
	(2.91)	(5.69)	(6.34)
χ^2*-statistic*	70.49***	75.05***	171.09***

Jointly estimated by 3SLS with corresponding columns in Table B2. Commission Rate is instrumented by Sales Person's Risk Aversion. Number of observations = 261. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors of coefficient estimates in parentheses.

TABLE B2: DETERMINANTS OF COMMISSION RATE

(Estimated jointly with Table B1 by 3SLS)

	(1)	(2)	(3)
Main Variables			
Price Delegation	0.01	-0.03	-0.06
	(0.05)	(0.05)	(0.05)
Sales Person's Risk Aversion	-0.20***	-0.23***	-0.17***
	(0.06)	(0.06)	(0.05)
Sales Person's Skill	0.13**	0.14**	0.23***
	(0.05)	(0.06)	(0.08)
Customer Heterogeneity	0.04	0.06	0.07
	(0.04)	(0.05)	(0.05)
Industry Demand Uncertainty	0.04	-0.02	-0.08
	(0.04)	(0.05)	(0.06)
Rapid Technological Change	-0.00	-0.06	-0.12*
	(0.04)	(0.05)	(0.06)
Control Variables			
Base Salary		-0.02***	-0.03***
		(0.00)	(0.00)
Number of Competitors			0.04*
			(0.02)
Log(Firm Size)			0.24***

			(0.07)
Firm Reputation			-0.14**
			(0.06)
Monitoring Difficulty			-0.03
			(0.07)
SIC36	0.10	0.22	0.19
	(0.15)	(0.16)	(0.18)
SIC37	-0.10	-0.31	-0.38*
	(0.21)	(0.22)	(0.23)
SIC38	0.27*	0.19	0.11
	(0.16)	(0.17)	(0.18)
Constant	2.00***	4.75***	1.04
	(0.74)	(0.93)	(1.32)
χ^2*-statistic*	49.72***	82.07***	99.41***

Jointly estimated by 3SLS with corresponding columns in Table B1. Price Delegation is instrumented by Log(Sales Person's Tenure). Number of observations = 261. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors of coefficient estimates in parentheses.

[†] We thank participants at the American Economic Association Meetings, NBER Organizational Economics Workshop, International Society for New Institutional Economics Conference, and Marketing Science Conference, as well as seminar attendees at Boston University, California State University at East Bay, Columbia University, Kansai University, and Santa Clara University. We also thank Robert Gibbons, Danielle Li, and Paul Oyer, the associate editor, and three anonymous referees for their comments, and our respective institutions for financial support. Finally, we thank Robert Picard for his assistance. The usual disclaimer applies.

[1] See e.g., John and Weitz (1989), Aggarwal and Samwick (1999), Lazear (2000), and Lo, Ghosh, and Lafontaine (2011) on the former, and Arrunada et al. (2001), Abernethy, Bouwens, and van Lent (2004), Acemoglu et al. (2007), Rajan and Wulf (2006), Graham, Harvey, and Puri (2013), and McElheran (2014) on the latter.

[2] Interestingly, DeVaro and Prasad (2013) find a positive association between incentives and delegation only for simple jobs, while they find a negative relationship for complex jobs (e.g., professional, technical, or scientific occupations such as cardiac surgeons). They explain this result using arguments from the multi-tasking literature as they argue that more complex jobs involve multiple tasks.

[3] In contrast, some studies rely on large samples of firms across unrelated industries, potentially involving hard-to-compare incentive schemes and delegation decisions (e.g., Wulf, 2007; DeVaro and Kurtulus, 2010).

[4] Several recent empirical studies of the relationship between delegation and performance pay rely on the framework in Prendergast (2002). These studies include delegation as an independent variable in performance pay regressions, assuming the former determines the latter (e.g., Foss and Laursen, 2005, Ben-Ner et al., 2012; DeVaro and Kurtulus, 2010, DeVaro and Prasad, 2013).

Studies that use data on company executives tend to assume that internal hierarchy is exogenously determined (Wulf, 2007; Shi, 2011).

[5] Instead, in Aghion and Tirole (1997) and Prendergast (2002) agency problems arise because the agent derives private benefits from certain actions. This is an unappealing assumption in the context of pricing delegation, however. Another rationale for centralization in the literature is the need for coordinated decision-making, as in Alonso, Dessein and Matouschek (2008; 2015) and other team theory models (see Thomas, 2010 and McElheran, 2014 for empirical tests). Again, coordination concerns do not appear to be relevant in our setting.

[6] See notably Joseph and Kalwani (1998), Misra and Nair (2011), and Larkin (2014) on the use of quotas in other contexts.

[7] Joseph (2001) also studies constrained price delegation to a sales force, but he focuses on a moral hazard problem in the effort the sales agent devotes to prospective customers. In contrast, in our model, the agency problem arises because the sales commission is based on the firm's revenues, resulting in very different predictions. Other models of price delegation to a sales force that focus on the role of asymmetric information include Lal (1986) and Mishra and Prasad (2004), but they do not consider constrained delegation.

[8] The assumption $c < v_H/2$ simplifies the exposition, but is not necessary for our qualitative results to hold.

[9] Tenure is affected by both the agent's choice and whether the firm wants to keep him so it is a measure of positive selection as well as experience. To fully endogenize this is beyond the scope of our study. We could equivalently assume that tenure reduces an agent's cost of effort.

[10] While these assumptions facilitate exposition, the results in this section hold as long as $q_{te} \geq 0$. For example, Propositions 1 and 2 also hold if $q(e,t) = \beta te$ such that the productivity of effort is larger for longer tenured sales persons. Moreover, since $q < 1$, $t < 1$. The interpretation of 1 unit

of t could be, for instance, 50 years, the maximum number of years a sales person could work for one company before retirement. In our data, 15 years is the maximum tenure.

[11] Since the agent's reservation utility W_R is binding at the optimum, the principal maximizes total gross profits, including the fraction α of revenues paid to the agent.

[12] As shown by Alonso and Matouschek (2007), under certain conditions, providing the agent with a delegation set is equivalent to an optimal direct mechanism without transfers.

[13] We could allow the agent to communicate messages about customer valuation to the firm. Nevertheless, under our simple assumption of a continuous uniform distribution, whenever such communication would be informative, the firm strictly prefers delegation (see Dessein 2002 for a formal analysis). Hence, communication never appears in our analysis.

[14] Customers in this industry expect to pay no more than the list price, i.e., they negotiate discounts from that price, so the firm must set its list price at least at this level if it is to sell at this price to the highest valuation customer. At the same time, setting the list price even higher is pointless or could even discourage customers.

[15] Commitment is possible under self-enforcing relational contracts (Baker, Gibbons, and Murphy, 1999), which fits our context since the sales persons in our sample are in long-term employment relationships with their employer. The average tenure of the sales people in our data is over four years. Thus reneging on, or changing the level of, pricing authority would be disruptive and costly. Occasionally, however, firms do take such actions with respect to a particular sales person.

[16] For example, let $(\beta^2)/2k = 3$, α = 5%, t = 0.2, c = 0.5 and $\bar{v}$ =1.5 so that for δ =0.50, $(v_L, v_H) = (1, 2)$ and $p_L^* \approx 1.01$. Solving explicitly for p_L in (2), we find that pricing flexibility (in percentage terms) is decreasing in δ for $\delta \in (0.50, 0.53)$, whereas it is increasing again for $\delta \in (0.53, 1.00)$.

[17] A more involved way of capturing environmental uncertainty would be to posit that $v \sim U[\bar{v} - \delta, \bar{v} + \delta]$, where $\bar{v} \sim U[v_L, v_H]$ is the industry demand or technology known to both agent and principal, but only realized after the pricing floor p_L^* has been set. Higher environmental uncertainty then corresponds to a mean-preserving spread of $\bar{v}$. In this set-up, it is easy to see that when the variance in industry demand or technology $\bar{v}$ is large relative to the local variance (i.e., the variance in v conditional on $\bar{v}$), then the principal will give the agent less pricing authority than if $\bar{v}$ were known to be $(v_L + v_H)/2$. Indeed, it would then be optimal for the principal to set a pricing floor p_L^* based on the highest possible realization of industry demand $\bar{v}$, and approve prices below p_L^* when justified based on a low realization of $\bar{v}$. A full-fledged analysis of ex-ante environmental uncertainty about $\bar{v}$ would involve modeling the petition and approval process by which the agent can appeal for prices below the pricing floor p_L^*, but this goes beyond the scope of the present paper.

[18] One can show that $\frac{d\alpha^*}{d\delta} > 0 \iff \frac{dp_L^*}{d\delta} < \frac{p_L^* - v_L}{v_H - v_L}$ (proof available from authors upon request). One example where this condition is violated is when t=0 and k is large so that $q^* \approx 0$ and $e_{p_L}^* \approx 0$. From (5), the pricing floor is then increasing in customer heterogeneity: $p_L^* \approx \frac{v_H + c}{2} = \frac{\bar{v} + \delta + c}{2}$. We further have that $\frac{d\alpha^*}{d\delta} < 0$ since $\frac{dp_L^*}{d\delta} \approx \frac{1}{2} > \frac{p_L^* - v_L}{v_H - v_L} \approx \frac{3\delta + c - \bar{v}}{4\delta} = \frac{1}{2} - \frac{v_L - c}{4\delta}$.

[19] Given our survey procedure, it is possible that informants systematically chose, e.g., their best customers or sales agents to report on. To address this, we assessed two customer-side measures – the profitability of the customer to the firm and the firm's satisfaction with this customer relationship – as well as one sales person characteristic, namely their tenure at the company, for distribution bias. The data exhibited large variation along all these measures, suggesting that the

manager-informants did not systematically choose to report on their most profitable customers or their most senior sales people.

[20] As mentioned earlier, industrial equipment manufacturers set list prices to be consistent across all sales territories, and they modify these only infrequently, so as to maintain consistent perceived value for their products. As a result, differences in the level of authorized discounts across sales people within a firm represent real differences in the level of delegation across these individuals.

[21] Unfortunately, we were not able to collect data on the commission rate directly.

[22] If firms used accelerating commission rates (as in, e.g., Lal and Srinivasan, 1993; Joseph and Kalwani, 1998; Oyer, 1998; 2000; Larkin, 2014), our measure would *underestimate* the true incentive intensity at the margin. But as mentioned in Section 2, we were told that such increasing scales are rarely used in these industries because of the long duration of the sales process.

[23] Our estimation equation is different from that suggested by Prendergast (2002)'s model, where delegation would explain the commission rate. His rationale is that an uncertain environment in which the agent has informational advantage leads to greater levels of delegation, which in turn affects the desired level of incentives the firm wants to offer its agent. See Foss and Laursen (2005), Ben-Ner et al. (2012), DeVaro and Kurtulus (2010), and DeVaro and Prasad (2013) for empirical studies that are based on Prendergast's model to look at the relationship between delegation and performance pay.

[24] When we estimate the last column without including *Monitoring Difficulty*, *Customer Heterogeneity* has a positive and significant effect at the 10-percent level.

[25] Hubbard (2000) distinguishes two notions of monitoring. The first notion refers to measuring output. In our context, sales are a good measure of output that is completely observable by the firm, so monitoring is not about getting a better measure of output. Hubbard's second notion

refers to input monitoring. In particular, he notes that the difficulty of monitoring agent's (input) activities hampers coordination and hence requires more delegation. He finds evidence consistent with this in the trucking industry. See also Lafontaine and Slade (1996) for similar arguments in the context of sales force management and franchising.

[26] These results also corroborate those in some of the empirical literature on transaction cost economics (Williamson, 1985) where environmental uncertainty has been found to be associated with more hierarchical – and hence more centralized – governance forms.

[27] The coefficient of 2.22 means $\frac{\partial(Price\ delegation)}{\partial(\mathrm{Log}(Tenure))}$=2.22 so that $\frac{\partial(Price\ delegation)}{\partial(Tenure)}|_{\overline{Tenure}} = \frac{2.22}{\overline{Tenure}} = \frac{2.22}{4.07}$ =0.55.

[28] When using log, the null hypothesis (of exogeneity) again could not be rejected, but only in those regressions with the full set of control variables.