Do Agents Game Their Agents' Behavior? Evidence from Sales Managers

By Alan Benson*

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By analyzing sales organizations, this paper constructs a firm-supervisor-agent model explaining the delegation of authority in organizational hierarchies, and provides evidence sales managers use this authority to align subordinates' staffing and incentives with their own interests rather than the firm's. Using detailed microdata from 244 firms that subscribe to a "cloud"-based service for managing sales performance and automating compensation, I parametrically estimate the model, identifying a "treatment bubble" of poor performing subordinates whose fourth-quarter sales are needed for their manager to meet a quota. I find these subordinates are more likely to be retained and receive downward quota adjustments compared to subordinates under managers who will not (or will) meet the quota anyway. I interpret these results as evidence organizational hierarchies struggle to align managerial incentives (and thereby firms' practices) with profit maximization, and draw upon organizational research to suggest how performance analytics software may inform employment practices and promote organizational efficiency.

The constraints on principals' ability to induce efficient behavior through their economic agents are the defining determinants of economic organization. In the classic principal-agent model, a principal (e.g. the firm, which provides employment and a pay plan) contracts directly with its agents (e.g. the worker, who provides productive effort). In practice, profit-maximizing principals are far-removed from rank-and-file agents. For example, shareholders of publicly traded firms

* PhD Candidate, MIT Sloan School of Management. This is a first draft of the third chapter of my dissertation and job market paper (exp. graduation, May 2013). I thank David Autor, Martin Conyon, Bob Gibbons, Ian Larkin, Paul Oyer, Mike Powell, and participants in the MIT Organizational Economics Seminar, MIT Economics Labor Lunch, MIT IWER Seminar, and the 2012 People and Organizations Conference at the Wharton School of the University of Pennsylvania for comments and advice. The usual disclaimer applies. Correspondence: alanmb@mit.edu.

rely on a long chain of intermediary executives and managers to set and monitor employment practices affecting workers on their behalf. As such, models invoking a profit-maximizing firm implicitly assume the interests of their intermediary agents, even if they are not identical to those of shareholders, are sufficiently aligned so that their ultimate employment practices also approximate profit-maximizing behavior.

Although it is well-known that incentives may encourage activities inconsistent with the interests of principals, evidence draws almost exclusively from the top and bottom of organizations (e.g. CEOs and rank-and-file workers; see Murphy 1999 and Lazear and Oyer 2009 for reviews). However, little empirical work examines how misaligned managerial incentives propagate to subordinates. This shortcoming is important, given that managers are the intermediary agents responsible for making decisions on behalf of the "Firm." Indeed, early organizational researchers dismissed that managerial decision making is governed principally by profit maximization. Based on their observations, they concluded managers are imperfect and self-interested coordinators of economic activity, that firms should not be treated as monolithic, and that the inability of organizational hierarchies to coordinate activities efficiently in turn determines firm structure, governance, and scope (classic studies include Baumol 1959; Chandler 1977; Coase 1937; Crozier 1964; Cyert and March 1963; Penrose 1959; Simon 1957, 1964; and Williamson 1963, 1967).[1]

This paper shows how sales hierarchies provide insight into why firms delegate authority over staffing and incentives to managers and how misaligned incentives created by managerial quotas propagate to subordinates. I construct a model yielding the prediction that firms delegate authority over staffing and incentive decisions to managers due to their ability to distinguish high-ability salespeople from those who are lucky (e.g. due to good market conditions, a good product, or a good territory). This allows managers to screen and incentivize salespeople more efficiently than would a firm that contracts only on output (sales).[2] Although pay-for-performance generally aligns managers' decisions with profit maximization, delegated authority and nonlinear incentives provide an opportunity and a motive for managers to shift sales to their desired measurement periods through decisions affecting subordinates.

Specifically, I test the hypothesis that, compared to managers far above or below their quotas, managers on the cusp of meeting their quotas are more likely to delay terminating subordinates

[1]This emphasis might be attributed to the three common strategies for acquiring data–using publicly-available accounting data, company-researcher data use agreements for single-firm studies, or sports statistics for athletes.

[2]For brevity, I use "sales" to refer to performance measures. In the data, performance measures also include presale, support, and renewal activities.

until the following fiscal year and to reduce their subordinates' quotas. To do so, I use novel and uniquely well-suited data on salespeople working at firms that subscribe to an on-demand (over "the cloud") sales performance management service. The data include longitudinal detail on the hierarchical positions, incentive plans, performance, and pay of 7,492 sales managers and their 61,092 immediate subordinates in 244 firms. To distinguish the interests of the sales managers from those of the firm and the subordinates, I exploit the fact (treated here as exogenous) that managers have a unique personal interest in achieving the marginal sales that meet their quotas. In particular, sales managers' quota attainments are typically determined by the cumulative credited business of their subordinates, and as such their incentives for boosting marginal sales differ from those of their subordinates or the firm.

[FIGURE 1]

To illustrate the puzzle, Figure 1 shows that the cumulative sales of the manager's subordinates often just reach the manager's quota. For both managers and their subordinates, there are nearly four times as many quotas surpassed within 5% as there are quotas missed within 5%.

Managers' decisions routinely shift the timing of sales. These decisions affect the timing and implementation of product pricing, product promotions, and sales campaigns. These decisions also affect the allocation effort and resources across presale, final negotiation, and support activities. This paper theorizes and corroborates the specific effect of managerial quotas on subordinate staffing and incentives. These are theoretically salient because they are partly delegated to managers, they are swayed by the nonlinear incentives provided by quotas, they affect rank-and-file subordinates, they are potentially inefficient, and they are at the heart of principal-agent models. I conclude organizational hierarchies struggle to align the interests of managers with profit maximization, and discuss implications for both managers and for organizational research.

I. Sales Management, Weak Monitoring, and Gaming in Sales

A. Background

Like rank-and-file salespeople, sales managers receive variable pay that can vary widely depending on measured performance. Unlike rank-and-file salespeople, sales managers' performance is measured largely by the cumulative sales of their subordinates. In the data, mean annual variable pay is about one-half of base pay for both managers and non-managers.

Variable pay includes commissions and bonuses at rates that depend on quota attainment. Quotas are specific thresholds at which workers typically receive a discrete bonus (in an archetypal quota-

bonus plan) and/or begin to earn commissions on marginal sales (in an archetypal commission plan). Quotas, bonuses, and commission rates are generally set in advance of a measurement period, but may be adjusted. Sales compensation plan designers view quotas as a method of targeting variable pay around marginal effort, insuring workers against risk, and setting expectations.

In addition to their pecuniary purpose, quotas also communicate minimum acceptable performance levels. Salespeople who exceed their quotas typically become eligible progressive bonuses or accelerators that increase the rate at which commissions are paid. Salespeople who consistently exceed their quotas may also be considered for promotions, transfers, superior leads, or superior accounts. Making quotas and other discrete benchmarks also confer prestige, influence, and symbolic rewards (Larkin 2009). Salespeople who do not meet quotas typically earn a base pay, which reduces risk borne by salespeople and provides income to new recruits. Such income is often temporary and may be phased-out or drawn from future variable pay (in the case of "draws"). Consistent performance below quota may be grounds for dismissal. Terminating a quota-achieving salesperson for performance reasons is often regarded as distasteful or a symptom of poor communication by management.

Quotas may also have a psychic effect on performance. Heath, Larrick, and Wu (1999), reviewing the psychology literature, find evidence that performance goals exhibit properties consistent with reference points in Prospect Theory. Psychologists typically find explicit targets can improve measured performance when they are challenging, specific, attainable, and supported by coaching and other practices (for reviews, see Shinkle 2012, Steel and König 2006). Although this literature is not conclusive, sales plan designers report their belief that quotas have psychological importance.

B. How Incentives Affect the Timing of Sales Activities

Outside of executives and sales, variable pay is often a small or negligible component of compensation. One reason is that incentive contracts encourage workers to "game"[3] plans by engaging in activities that are correlated with performance measures but contrary to the interests of the firm. Examples abound of how misaligned incentives prompt undesired behaviors.[4] At the top of organizations, executives adapt accounting procedures, accrual procedures, and voluntary disclosures to maximize bonus rewards (Aboody and Kasznik 2000, Healy 1985, Yermack 1997). At the bottom of organizations, several studies show how seemingly innocuous pay-for-performance

[3]Interviewees often view "gaming" as pejorative, noting that it is the responsibility of the firm to design incentives and for salespeople to pursue them. I use this term as shorthand.

[4]For additional examples, see Baker (1992), Ethiraj and Levinthal (2009), Feltham and Xie (1994), Holmstrom and Milgrom (1991), and Kerr (1974).

schemes have backfired.[5] The recent financial crisis, incidents of rogue trading, and the "London Whale" have intensified debate over whether financial institutions effectively manage risk and whether executives should be held accountable for the actions of distant subordinates.

Despite their ubiquity in sales, empirical work shows misaligned and nonlinear incentives distort sales activities as well. Using data from an enterprise software vendor, Larkin (2007) finds that accelerating quarterly commissions lead salespeople to use discretionary discounts to concentrate transactions into fewer quarters, costing the employer an estimated 6-8% of revenues. Using Compustat data, Oyer (1998) exploits variation in fiscal years by company and within industry to show that manufacturing firms' sales rise in the fourth quarter. He interprets this finding as consistent with the incentive effects of annual quotas, although the firm-level data do not permit analysis of gaming at any level of the organization. Incentives to boost the size of subscriptions led account managers at Dun & Bradstreet to overstate their clients' historical usage, spurring millions of dollars in lawsuits (Roberts 1989).

Sales managers and sales compensation consultants interviewed for this study describe several additional practices salespeople and sales managers use to shift credit across measurement periods. Salespeople may boost sales figures by enticing distribution channels to place large orders to keep as inventory, a practice referred to as "channel stuffing." Salespeople may delay closing deals until future measurement periods, a practice referred to as "sandbagging." Salespeople and managers may exchange credit for sales across measurement periods. Salespeople and managers may misrepresent the quality of their territory to affect the sales forecasts used as the bases of their quotas. Sales managers can provide incentives, called "SPIFs," directly to salespeople at channels who sell their products.

Employer "ratcheting," or the practice of moving quota thresholds based on past performance, also provides an incentive to manipulate the size and timing of sales. Organizational researchers conducting fieldwork have long recognized the pervasiveness of restricting output to avoid quota increases.[6] Murphy (2000) shows that firms that set managerial quotas according to internal

[5] Job Training Partnership Act training agencies manipulate the timing of students' graduation dates to boost the share of graduates with jobs (Courty and Marschke 1997, 2003). In lending, the desire to avoid appearing to have poorly assessed borrowers' risks led bank loan officers to fail to disclose bad news to their supervisors (Hertzberg, Liberti, and Paravisini 2007). Typists at Lincoln Electric paid by the keystroke spent lunch hours repeating a single key (Fast and Berg 2005). After implementing a per-passenger commission, bus drivers in Chile had a higher incidence of traffic accidents than prior to the implementation or compared with a competing bus company that did not pay by commission (Johnson, Reiley, and Muñoz 2011).

[6] For example, this practice has been labeled "soldiering" by Frederick Winslow Taylor (1911), "targeting a bogey" by Elton Mayo (Roethlisberger and Dickson 1939), and "quota restriction" by

standards (such as a budget or past performance) have less-variable bonuses and smoother earnings than those that use external standards that cannot be gamed. Leone, Misra, and Zimmerman (2006) find evidence of dynamic sales quota ratcheting in a Fortune 500 firm. They note that quotas rise with over-performance more readily than they fall with under-performance. Asymmetric ratcheting further compresses incentives around meeting quota by weakening the benefits of missing quotas (because quotas are unlikely to fall) and weakening incentives to exceed quotas (because quotas are likely to rise).

C. How and Why Firms Monitor Sales Activities

Sales hierarchies devote considerable resources to identifying and retaining salespeople who exceed quotas. In the data, turnover is 47% per year, and sales performance is highly skewed.[7] However, in many cases it is difficult for the firm to attribute sales numbers to the skill of a salesperson, rather than exogenous factors such as the quality of the product, territory, or market conditions. As such, managers play a large role in identifying and retaining high performers.

Early organizational research emphasizes how managerial behaviors depart from profit maximization. Coase (1937), Penrose (1959), and Williamson (1967) invoke diminishing returns to management and the alienation of managerial interests to explain the limited growth of firms. Simon (1957) argues managers "satisfice," adopting decisions that meet some non-maximizing acceptability threshold. Cyert and March (1963) argue managers possess neither the motives nor the cognitive means to make profit-maximizing decisions, and managers' private information allows them to pursue tangential objectives. Crozier (1964) argues that hierarchies use impartiality as a pretense for the centralization and consolidation of organizational power. Chandler (1977) argues that managerial hierarchies are independent sources of power, permanence, and continued growth. Baumol (1959), Gordon (1961), and Williamson (1963) interpret profit as a constraint to which manager's other goals–such as job security, influence, prestige, and advancement–may be pursued.

Recent advances in agency theory incorporate the role of supervisors in reducing gaming (see Gibbons 2005 or Miller 2005 for a review). Monitoring allows firms to condition employment and payment on agents' inputs (such as effort) and discourages opportunism. To prevent opportunism and politicking among managers, firms may use bureaucratic rules and internal auditing. When

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Donald Roy (1953).

[7]The sales industry often cites the "80-20 rule," the rule-of-thumb that 80% of sales are made by 20% of the salesforce. In the data, this slightly exagerates the variation in sales performance at most firms. Prior to controlling for tenure, about 25% of salespeople are responsible for 75% of sales at the median firm. The variation is greatest for sales representatives at enterprise software companies and narrowest for engineers and support occupations.

performance measures are not contractible, firms may commit to subjective awards by relying on its reputation or by delegating subjective awards to an impartial supervisor. Subjective bonuses have other challenges, however; managers use evaluations to distribute performance rewards as they see fit, potentially eliciting cognitive biases, influence activities, and perceptions of unfairness. Conyon and He (2004), using evidence from CEO compensation committees, find three-tier agency models are better able to explain decision-making among executive compensation committees, compared to managerial power and collusion models.[8]

Social psychologists have examined why workers and managers pursue an organization's interests, even when such activities are unrewarded, and the circumstances under which individuals are willing to harm the organizations or other individuals to pursue personal goals. Bennett and Robinson (2000) and Berry et al. (2007) find that individuals who commit deviant behaviors harming individuals are also more likely to commit deviant behaviors harming the organization. Organizational researchers also offer explanations why the solutions offered by the standard agency theory may not work in practice. Neihoff and Moorman (1993) find that monitoring reduces such organizational commitment, and Gneezy and Rustichini (2000) find pecuniary penalties reduces guilt for breaking norms. Nickerson and Zenger (2008) hypothesize that perceptions of unfairness, envy, and dissatisfaction with relative pay restrict efficiency in settings such as sales, where individuals are highly motivated by pecuniary rewards. Research by Benford and Snow (2000), Kaplan (2008), and Obloj and Sengul (2012) suggest managers will learn to frame their activities within new organizational initiatives, and learn to game their plans.

Salespeople are stereotypically driven by incentives rather than loyalty to their firms, as reflected by high turnover rates and high variation in compensation that typifies sales settings. Perhaps due to these reasons, information is rarely observed or communicated perfectly in sales hierarchies. For example, sales managers and their subordinates learn how difficult it is to sell a given product in a given territory, while other functions (potentially sales operations, the CFO, or marketing) use past performance, subjective reports, or other sources of information to produce forecasts. One purpose of these forecasts are to set quotas, making subordinates' reports potentially unreliable.

[8]For theoretical treatment on contracting or monitoring effort, see Akerlof and Yellen 1986, Calvo and Wellisz 1978, Harris and Raviv 1978, Joseph and Thevaranjan 1998, Shapiro and Stiglitz 1984. On subjective bonuses, see Baker, Gibbons, and Murphy (1994) or Bull (1987). On bureaucratic rules and internal monitoring, see Baliga (1999), Kofman and Lawaree (1993), Milgrom (1988), Milgrom and Roberts (1998), Suzuki (2011), or Tirole (1986, 1992). On delegating awards to impartial supervisors, see Strauz (1997). On evaluation biases and gamesmanship, see Kaplan and Henderson (2005), Milkovich and Newman (2011: 374-5), or Prendergast and Topel (1992). Wu (2011) finds a Chinese newspaper reduced opportunism by centralizing authority, but did so at the expense of managerial incentives to support subordinates.

While sales managers are responsible for monitoring gaming behavior, nonlinearities in their incentive plans encourage activities not perfectly aligned with profit maximization. Moreover, managers typically focus their effort on negotiating and closing deals–the point at which there is the greatest opportunity to affect the timing of measured performance.

As such, sales organizations also rely on a variety of reporting practices to reduce information asymmetries, maintain incentive alignment, and discourage gaming. Customer relationship management (CRM) tools allow salespeople to report progress on their sales pipeline and share information regarding how clients' purchasing decisions are made. These too may be gamed; interviewees report that subordinates may misrepresent the status of intermediary sales activities to avoid interventions by managers, whose desired closing date for sales may conflict with their own, or to avoid others from expropriating their client relationships and accounts. Moon and Mentzer (1999), in a study of a sales organization, found salespeople grossly misrepresented forecasts and the state of their sales pipeline, which they believed were used to adjust quotas.

Some firms use subjective bonuses or promotions to reward managers perceived to be acting primarily on the interests of the firm (for evidence outside sales, see Cappelli and Conyon 2011). Some firms restrict managers' staffing, incentive, and pricing decisions, requiring large decisions to be approved or reviewed by sales operations or superiors. Indeed, the effort and expense firms dedicate to designing plans, monitoring activities, and improving coordination suggest that hierarchical coordination is indeed costly.

II. Managerial Quotas' Effect on Staffing and Incentives

The previous sections describe why managers have a wide variety of interests in addition to the profitability of the firm (including less marginal effort, developing their human capital, etc.), and how sales organizations seek to align managerial activities to the firm's interests through incentives, monitoring, and culture. This study focuses on the manager's interest to achieve the discrete pay, recognition, and job security associated with quota attainment. While firms also desire that their managers meet and surpass their quotas, this study focuses on managerial behaviors that (i) affect the staffing and incentives of subordinates, (ii) are encouraged by annual quotas, and (iii) are consistent with the interests of the manager, and not the interests of the firm or subordinates. Specifically, this study examines the timing of termination decisions and subordinate quota adjustments.[9]

[9]Perhaps the best-identified example of the effect of manager's incentive plans on their subordinates' employment and performance is Bandiera, Barankay, and Rasul's (2007) field experiment on supervisors of fruit-pickers. They find that changing supervisors' pay from a flat rates

A. Managerial Quotas and Subordinates' Staffing

Developing a sales team is among a sales manager's chief responsibilities. This involves recruiting, training, assisting, and disciplining subordinates. Because managers' performance is measured primarily through the cumulative sales of their subordinates, their plans incentivize them to build productive teams.

However, this study's interviewees report that quotas can affect the timing of staffing decisions. Hiring and training new salespeople consumes time. In sales settings involving complex products or services, the typical applicant for a sales position is intensively screened, recruits receive training and/or a shadowing period, and newly-trained salespeople are given several months to develop skills and establish a "sales pipeline" beginning with initial leads and ending with a purchase order (and potentially installation, renewal, and support). Salespeople refer to this as the "ramp up" period. The sales industry often uses twice the length of the sales cycle as a heuristic for the ramp up time. For business-to-business sales, which constitute the majority of sales in these data, interviewees suggest a typical ramp up time would be six to twelve months. This estimate is consistent with results presented in the next section.

For this reason, replacing a poor-performing but experienced salesperson with a new recruit is an investment involving the substitution of present sales with greater expected future sales as the new recruit is hired and ramped up; in Oyer's (1998) framework, retaining a poor performer is a way for managers to "pull in" sales from future measurement periods. Therefore, annual quotas create incentives for managers to retain poor-performing subordinates who would otherwise be terminated.

A natural question arising from agency theory is—why do firms delegate termination decisions to managers, rather than specifying termination criteria in contracts? Based on interviews, I propose firms delegate authority for termination decisions to managers to employ their private knowledge of their subordinates' abilities, since performance measurements may be clouded by luck.[10] Bad luck may include non-contractible events beyond the salesperson's control, such as the debut of a

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to a piece rate boosts efficiency by leading them to be more selective in whom they recruit and leads them to focus effort on assisting the most productive workers. Because workers consist of migrants who lived on the farm and their work consists of picking fruit, recruitment costs are negligible, the difficulty of the task is relatively well-known and homogenous, workers require minimal training, and there are no quotas. These characteristics distinguish fruit-pickers from the complex sales settings that distort incentives among sales managers.

[10]Incentive plans sometimes try to get around this dilemma through pay for "relative" performance, such as sales tournaments. These are also challenging to implement, since exogenous shocks may be specific to an individual salesperson, relative performance measures discourage teamwork, and because anticipated tournaments encourage sandbagging.

competitor's superior product, an economic slump in the assigned territory, unfavorable exchange rates, or close calls on big sales. Managers, who observe a workers' ability and luck may help firms screen and retain salespeople who are highly able but unlucky.[11]

To analyze the decision to employ a supervisor and the effects of a sales quota on a supervisor's staffing decisions, first consider the following firm-worker model where the firm observes performance but not skills directly. For now, I abstract from the wage and effort decisions, and the only choice is the firm's decision to retain or replace a worker (implicitly at a worker's reservation rate). The model may be thought of as a case of a firm hiring a worker for a unique job tied to a valuable asset; I abstract from the firm's cost of acquiring that asset and the external competition that would lead the firm to adopt a reservation level of profitability for that asset and otherwise replace the worker. For example, for a medical device manufacturer, the asset may be the exclusive ability to sell a product to hospitals in California, which is tied to a specific sales job; for a newspaper, the asset may be an existing set of advertisers, who are tied to account manager.[12]

Firms are risk-neutral, there are infinite periods, and firms discount future periods at δ. In period $t = 1$, the firm hires a worker, and then production occurs with the firm observing output. In periods $t > 1$, the firm chooses an action $\mathcal{A}_r^f \in \{retain, replace\}$, and then production occurs with the firm observing output. The production of worker i in period t is

$$y_{it} = r_{it} + \alpha_i + \varepsilon_{it} \tag{1}$$

where $r_{it} \in \{0, 1\}$ denotes whether the worker is "ramped up," $\alpha_i \in \{0, 1\}$ denotes the worker's period-invariant ability, and $\varepsilon_{it} \in \{0, 1\}$ denotes the worker's period-specific luck. Let $\Pr(\alpha_i = 1) = \Pr(\varepsilon_{it} = 1) = 0.5$, and $r_{it} = 0$ in the worker's first period of employment and $r_{it} = 1$ thereafter if that worker is ever retained. A ramped up worker may be thought of as a worker with accumualted firm- and client-specific human capital and a mature sales pipeline. Crucially, suppose the firm observes y_{it} and r_{it}, but does not observe α_i or ε_{it}; the firm observes performance but not the

[11] Analytically, the value of the supervisor in this setup most-closely resembles Harris and Raviv's (1978) model in which a firm is willing to pay to contract on a risk-neutral worker's effort rather than output. The strategic manipulation of information to affect decision-making has long traditions in organizational theory and decision theory (see especially Barnard 1938; Crozier 1964; Cyert and March 1963), with agency theory giving increasing attention to incorporating bureaucratic rules and politicking behavior into (see Gibbons, Matouschek, and Roberts 2012; or Tirole 1986, 1992; for a review).

[12] Here, assets might be used interchangeably with 'resources' in the resource-based view parlance; see Barney (1991), Rumelt (1984), or Wernerfelt (1984). That is, these assets are inherently valuable, firm-specific, and not easily imitated by competitors.

worker's ability or luck directly. It can be shown that, for $\delta \in (0.5, 1)$, the net present value (NPV) of a new recruit exceeds the NPV of a revealed low-ability worker, and the firm replaces a worker if and only if production is $y_{it} = 0$ for a new recruit ($r_{it} = 0$) or if production is $y_{it} = 1$ for an experienced worker ($r_{it} = 1$).[13] These are the two sufficient conditions for the firm to learn $\alpha = 0$.[14]

For $\delta < 0.5$, the immediate value of an experienced worker ($r_{it} = 1$) is greater than the expected future value of identifying a high ability worker ($\alpha_i = 1$) such that the firm retains all incumbents regardless of ability. Therefore, for the rest of this model I impose the parameter restriction $\delta \in (0.5, 1)$. In this case, the NPV of workers are:

$$v_N = 1 + \delta(0.5v_H + 0.5v_L) \tag{2}$$

$$v_H = 2.5(1 - \delta)^{-1} \tag{3}$$

$$v_L = 0.5v_N + 0.5(1.5 + \delta v_L) \tag{4}$$

where v_N denotes the NPV of a new recruit, v_H denotes the NPV of an experienced high ability worker, and v_L denotes the NPV of a low ability worker. For $\delta \in (0.5, 1)$, $v_N > v_L$ and the firm replaces revealed low ability workers with new recruits. By substitution, the NPV of a new worker is $v_N = (1 - 0.25\delta - 0.125\delta^2)(1 - 1.75\delta + 0.75\delta^2)^{-1}$.

Now, suppose instead that the firm may choose to delegate the replacement decision to a supervisor. I assume the supervisor is risk-neutral and may be paid a reservation rate from any surplus the supervisor generates (thereby allowing us to abstract from supervisor turnover). The crucial assumption is that the supervisor observes (but cannot verify) productive inputs α_i and ε_{it}.[15]

Formally, if the firm does not to hire a supervisor, play proceeds as above. If the firm hires a supervisor, in period $t = 1$, the supervisor hires a worker, production occurs, and then the supervisor observes α_i, ε_{it}, and r. In periods $t > 1$, the supervisor chooses an action $\mathcal{A}_r^s \in \{retain, replace\}$,

[13] This decision rule, in which a firm conditions terminations on both performance experience, is also consistent with the tendency for firms to raise quotas as a new recruit is ramped up.

[14] Note that, by construction, the firm's posterior belief regarding the worker's ability is equal to the anterior belief for "medium" performance, $\Pr(\alpha_i = 1 | r_{it} = 0, y_{it} = 1) = \Pr(\alpha_i = 1 | r_{it} = 1, y_{it} = 2) = 0.5$. This simplifies the exposition.

[15] In practice, firms' performance evaluation procedures and customer relationship management tools may be an example of how the firm may try to verify α_i and ε_{it}. Such evaluations are notoriously unreliable and subject to bias, with meaningful subjective assessments of subordinates' abilities eschewed by managers in the interest of avoiding conflict (Bretz, Milkovich, and Read 1989). Baliga (1999) shows that firms may choose to hire a supervisor even in the prescence of non-verifiable information and the potential for collusion.

production occurs, and then the supervisor observes α_i, ε_{it}, and r. Let v^s denote the NPV of a subordinate with a supervisor.

The supervisor's contract specifies a piecerate and bonus for production exceeding a quota, Q_i, normalized to zero. Define the supervisor's total quota attainment in the event the subordinate is retained as

$$Q_i^H \equiv Q_i^L + y_{it} \tag{5}$$

where $Q_i^L \in [-5, 5]$ is a random exogenous variable denoting what the quota attainment would be without subordinate i's contribution, and y_{it} is the subordinate's contribution. Let the supervisor's contract take the form $w_{it} = cS_{it} + b_{it}$, where $c \geq 0$ is the rent-sharing (commission) rate, $S(\delta) \equiv v_N^s - v_N$ is the surplus created when the firm hires the supervisor, and b_{it} is a bonus, where $b_{it} = B \geq 0$ if $Q_i^L + y_{it} \geq Q_i$ and zero otherwise.

The firm can make terminating low-ability subordinates strictly incentive compatible for all values Q_i^L by choosing an arbitrarily-small c and by setting $B = 0$, *i.e.*, by eliminating the incentives for meeting quota and paying a linear piecerate. To see this, note that when the manager replaces low-ability workers, the firm's NPV of new, high-ability, and low-ability workers are:

$$v_N^s = 1 + \delta(0.5v_H^s + 0.5v_L^s) \tag{6}$$

$$v_H^s = 2.5(1 - \delta)^{-1} \tag{7}$$

$$v_L^s = v_N^s \tag{8}$$

By substitution, the value of the supervised new worker is $v_N^s = (1 - 0.25\delta)(1 - 1.5\delta + 0.5\delta^2)^{-1}$, which is greater than the value of the unsupervised worker, v_N, yielding $S(\delta) > 0$ for $\delta \in (0.5, 1)$. Intuitively, the rent-sharing rule makes it incentive compatible for the supervisor to use the private information of α_i and ε_{it} to accelerate the screening process for new workers.[16]

Although the model predicts firms may induce supervisors to terminate low ability subordinates by providing simple linear incentives, such plans are exceedingly rare in practice. Rather, incentive

[16]The model features firms that learn the ability of the worker over time. This is because ε_{it} is an independent and random draw in each period. For firms, the more troubling (but plausible) scenario is that ε_{it} is serially-correlated within a position; since individuals are employed at positions over time, firms may misattribute sustained high performance to the individual rather than the position (e.g. a good territory). If managers enjoy private information regarding the value of the firm's assets, this could allow managers to extract sustained rents on this information by pursuing personal objectives (such as pulling in sales, as above, or also collusion with subordinates, nepotism, or so on).

plans routinely feature quotas and other target-based goals. Unfortunately, there is no standard, empirically-established modeling technique yielding quotas and discrete incentives in incomplete contracts (for a theoretical discussion, see Frankel 2011, Kim 1997, Levin 2003, Oyer 2000, Park 1995, Steel and Konig 2006). Rather, consider the manager's decision whether to replace an experienced ($r_{it} = 1$), low-ability (α_i) worker when a bonus for meeting a quota ($B > 0$) is treated as exogenous.

For $B > 4cS(\delta)$, contrary to the desires of the firm, managers retain low ability workers when $Q_i^L \in [-2, -1]$. That is, when the bonus is sufficiently high, rent-sharing is sufficiently small, and the future is sufficiently discounted, quotas lead managers on the cusp of meeting a quota to pull in sales by retaining experienced, low-ability subordinates.[17] Intuitively, because the experienced worker enjoys $r_{it} = 1$ with certainty whereas the new recruit enjoys $\alpha_i = 1$ with probability 0.5, the immediate production for an experienced, low-ability worker first-order stochastically dominates production for a new recruit.

Figure 2 illustrates how quotas distort incentives to screen low-ability workers.

[FIGURE 2]

The model's predictions are driven by managerial incentives to meet a quota. For identification purposes, this prediction is particularly powerful because the treatment concerns an interior range of quota attainment values. However, perhaps the larger distortion emerges from commission accelerators, which make pay convex in sales and provide incentives to concentrate sales into fewer measurement periods. Although the prediction that managers push out sales by replacing poor performers when they are far below quota may be unintuitive, interviews suggest this is common when the manager's job is secure and marginal incentives are weak; interviewed sales managers referred to the general practice of concentrating losses in a single measurement period (including making staffing changes) as "taking a bath."

Drawing from interviews and from the model they inform, I hypothesize that annual quotas lead managers to refrain from terminating poor-performing subordinates late in measurement periods if the poor performer's sales are needed for the manager to meet quota, and to terminate poor performers late in the measurement period if doing so is unlikely to affect whether the manager will meet quota.

[17] Note that an implication of the model is that gaming around quotas could be reduced by boosting local linear incentives around the threshold and reducing the descrete benefits of achieving it.

HYPOTHESIS 1: *Managers will delay terminating poor performing subordinates until future measurement periods if and only if those subordinates are essential to the manager's quota achievement (i.e., subordinates are "quota-critical").*

This hypothesis requires four specific hypothesis tests. For months in the fourth fiscal quarter, I hypothesize that turnover of quota-critical poor performers will be lower than (H1a) turnover among poor performers whose manager *would not have* met quota anyway, and (H1b) turnover among poor performers whose manager *would have* met quota anyway. Furthermore, I examine whether these foregone turnovers are delayed until the following fiscal year. Specifically, in the month following the annual measurement period (the "thirteenth" fiscal month), I hypothesize the turnover of quota-critical poor performers will be higher than (H1c) turnover among subordinates whose managers did not meet quota, and (H1d) turnover among managers who did meet quota, but would not have without the subordinate's credit.

B. Managerial Quotas and Subordinates' Incentives

The second hypothesis concerns the alignment of subordinates' incentives with managers' interests. In particular, I examine whether subordinates are more likely to receive quota adjustments in the fourth quarter when the manager is in the neighborhood of reaching a quota.

Quota adjustments allow firms to adapt incentives to unforeseen circumstances. Otherwise, salespeople who are far below their quota for reasons unrelated to their prior effort may suffer from weak marginal incentives late in measurement periods, prompting them to quit or hoard sales until the next measurement period. To discourage salespeople from hoarding nearly-closed deals (commonly referred to as "sandbagging"), managers are typically instructed to reduce quotas only for reasons outside a worker's control, to communicate how circumstances meet predetermined criteria for quota adjustments with subordinates, and be mindful of adjustments' reputational effects.

In context of the model, I interpret this as evidence that managers observe α_i and ε_{it} prior to production, are delegated authority to choose $\mathcal{A}_q^s \in \{\text{keep quota, reduce quota}\}$, and that firms want managers to choose to keep quota for $\{\varepsilon_{it} = 1, \alpha_i = 1\}$, to reduce quota for $\{\varepsilon_{it} = 0, \alpha_i = 1\}$, and to fire the worker (as before) for $\alpha_i = 0$. The quota adjustment is a decision that creates surplus if the quota is kept for the output corresponding to $\{\varepsilon_{it} = 0, \alpha_i = 1\}$ and is reduced for the output corresponding to $\{\varepsilon_{it} = 1, \alpha_i = 0\}$. Intuitively, quotas specify an output level, but the key assumption is that firms cannot contract quota adjustments on α_i or ε_{it}, just as they could not for terminations. However, the immediate productivity boosts only depend on y_{ij}; a downward quota

adjustment may boost marginal incentives when production is low either due to bad luck or lower prior production due to low ability.

Although firms may immediately boost marginal incentives by adjusting quotas for all subordinates far below their quotas late in measurement periods, in practice, downward adjustments are not routine. This is because downward adjustments are also implicitly costly, as they distort incentives and harm morale if adjustments are anticipated or not viewed as exogenous. Otherwise, salespeople may ratchet effort, sandbag sales, and misrepresent forecasts early in measurement cycles in anticipation of adjustments. Subordinates may also interpret downward adjustments as "selective intervention," and evidence of favoritism, entitlements, or managerial opportunism. These beliefs may impair the firm's or the manager's ability to commit to future quota adjustments only for exogenous and pre-defined circumstances (Foss 2003).[18]

I interpret this to signify that a profit-maximizing firm would like to condition a quota on ε_{it} and credibly commit to it in advance, thereby avoiding moral hazard and sandbagging if downward adjustments are expected even if $\varepsilon_{it} = 1$. However, because firms observe only y_{ij} and not ε_{it}, they delegate quota adjustment decisions to a supervisor. Because contracts specify y_{ij} and the quota's effect on workers' effort effective for both $\{\varepsilon_{it} = 0, \alpha_i = 1\}$ and $\{\varepsilon_{it} = 1, \alpha_i = 0\}$, supervisors on the cusp of making a quota retain poor performers and provide a downward quota adjustment. As such, providing a downward quota adjustment for a $\{\varepsilon_{it} = 0, \alpha_i = 1\}$ worker is also tantamount to pulling in sales, as it boosts immediate incentives but invites future moral hazard as subordinates sandbag effort in anticipation of quota reductions.

The second hypothesis examines whether managers on the cusp of meeting their quotas are more likely to reduce subordinates' quotas.

HYPOTHESIS 2: *Subordinates are more likely to have their quotas adjusted when their manager's ultimate quota attainment will be near the quota threshold.*

While a quota adjustment is a relatively interpretable and standardized outcome variable, quota adjustments are arguably not the main way managers shift subordinates' incentives. Managers may also shift incentives by changing subordinates' implicit commission rates. For example, discretionary bonus pools may be distributed through targeted commissions and bonuses, through incentives for channels, through rewards for selling a certain product or to a certain client

[18]Indeed, firms recognize that quotas can become out of reach for subordinates, but rather than adjusting quotas downward, may tolerate the sandbagging and hoarding to avoid the reputational costs of downward quota adjustments when the exogenous circumstances cannot be verified.

("bounties"), through tournaments, or through other means. For salespeople greatly exceeding their quotas, a downward adjustment can boost marginal incentives by moving the salesperson to a higher commission rate tier.

The empirical strategy requires distinguishing subordinates who managers believe necessary to meet their quota. As such, the model relies on calculating each parameter in $Q_i^H \equiv Q_i^L + y_i$, and examining the turnover and quota adjustments among poor performing subordinates for whom $Q_i^H > 100\%$ and $Q_i^L < 100\%$.

III. Data

A. Description of the Data

Data come from a firm that offers on-demand (over "the cloud") sales performance management (SPM) software. Data include how 22 million transactions are credited to 7,492 sales managers and their 61,092 immediate subordinates in 244 client firms. Client firms upload their compensation plans to a server, and then the clients' salespeople log in to the server (e.g. through a computer or smart phone) to report credited transactions and track their progress toward quotas or other benchmarks. The service is designed to make incentives and real-time performance transparent to salespeople and their managers, to calculate and automate compensation, to enable monitoring, to produce an audit-trail, and to promote flexibility in adapting compensation plans. Data begin in January 2008 and end in October 2011, although not all firms are represented throughout this period. No one firm represents more than 13% of workers or worker-months. Table 1 provides descriptive statistics.

[TABLE 1]

For each worker within a position, relevant data include a unique worker identifier (linkable if a person changes positions), a job title, a position title, the parent position, and the compensation plan. Position and parent position identifiers allow the construction of longitudinal organizational hierarchies, which also determine performance monitoring and other privileges within the SPM software. The most common job titles among workers with one level of subordinates are 'territory manager,' 'sales director,' 'regional director,' 'regional manager,' 'sales engineer manager,' and 'regional vice president.' Each transaction includes a timestamp, the share of credit for each worker credited on the transaction, the amount and currency of the order, and the incentive plan to which the credit pertains. Each credited transaction further specifies associated quotas, commissions, and bonuses. Pay calculations from credited business are checked against a summary of terminal

payments for each worker's payroll period. Likewise, annual quota attainment calculations made from quota thresholds and credited business are checked against the SPM software's transaction-level rolling measure for percent quota attainment, which was updated in real-time and made visible to workers and managers via the client software's virtual dashboard. Because calculated pay may be automatically linked to payroll, forecasts, and audit reports, it is unusually incentive compatible to enter plans and transactions accurately.

The data are unusually rich in that they allow a large number of workers' pay and performance to be tracked longitudinally and in a fashion that is reliable and standardized across firms. Because data come from an on-demand SPM software service, they largely avoid the selection dilemmas presented by data from single firms that opt-in as research sites. Likewise, this also helps address external validity concerns inherent to single-firm studies. However, the data also feature limitations. Analytically, the chief limitation is that employment is subject to truncation; for example, some salespeople enter the data when the company subscribes to the service or are still employed when the data end. Because it is optional for system administrators to input incumbents' hire dates, tenure cannot always be determined for workers employed prior to the subscription to the SPM service. Although not essential to the analysis, the data offer two descriptive limitations. First, non-monetary rewards are not reported in the system; these may include prizes with great pecuniary or psychic value. Second, the data do not include education, demographics, or other descriptives sometimes available in empirical personnel research.

Compared to single-firm data, it is also difficult to identify and describe the institutional detail underlying data collected by on-demand SPM software. Single-firm studies typically complement quantitative results by interviewing workers whose experience is largely-similar to those in the data (Ichniowski and Shaw 2009 refer to this process as "insider econometrics").

B. Bringing the Data to the Model

The model yields the prediction that the manager will be less likely to terminate poor performing subordinates and more likely to provide downward quota adjustments when the subordinate's sales are needed for the manager to meet a quota. To do so, the data must distinguish subordinates within the "treatment bubble," whose sales are needed for the manager to make quota. In the model, subordinates inside the treatment bubble are those for whom $Q_i^H > 100\%$ and $Q_i^L < 100\%$; those below the treatment bubble are those for whom $Q_i^H < 100\%$ and $Q_i^L < 100\%$ (the manager would miss quota anyway), and those above the treatment bubble are those for whom $Q_i^H > 100\%$ and $Q_i^L > 100\%$ (the manager would make the quota anyway).

First, I estimate estimating Equation 1, $y_{it} = r_{it} + \alpha_i + \varepsilon_{it}$, the production given the productive inputs of being "ramped up," ability, and temporarily lucky. Second, I estimate terms in Equation 5, $Q_i^L + y_{it}$, the quota attainment absent the subordinate's contribution plus the subordinates contribution. By definition, this yields Q_i^H.

Subordinate's Production y_{it}. To estimate the subordinates's contribution $y_{it} = r_{it} + \alpha_i + \varepsilon_{it}$, I estimate an OLS spline regression for the total monthly business credited as a function of tenure (the "ramp up," r_{it}), a worker fixed effect (the worker ability, α_{it}), and the noise term (the worker's period-specific luck, ε_{it}). I use a spline regression with quarterly knots because the functional relationship between sales and tenure as a compromise between the weak assumptions of month fixed effects and power of linear approximations. I do this for each standard job classification within a firm. The regression takes the form

$$\ln(y_{it}) = \underbrace{\beta_0 + \beta_1 M_{3it} + \beta_2 M_{6it} + \beta_3 M_{9it} + \beta_4 M_{12it}}_{\substack{\text{Month Spline Terms} \\ (\text{ramp up } r_{it})}} + \underbrace{\alpha_i}_{\substack{\text{worker f.e.} \\ (\text{ability } \alpha_i)}} + \underbrace{\varepsilon_{it}}_{\substack{\text{residual} \\ (\text{luck } \varepsilon_{it})}} \tag{9}$$

where i is the individual salesperson, t is the month, $\ln(y_{it})$ is the natural logarithm of the salesperson i's total credited business in month j,[19] M_3, M_6, M_9, and M_{12} respectively denote months into the first, second, third, and fourth quarters, are zero for months prior to their respective quarters, and are three for months succeeding their respective quarters. M_{13} is zero for months prior to one year tenure, and otherwise denotes months greater than twelve. α_i is an individual fixed effect. I perform this regression separately for 834 standard job category-firm combinations that collectively feature 71,001 employment spells and 679,523 employee-months with credited transactions. Table 2 presents these regressions at the industry (rather than firm-job) level of aggregation. The worker fixed effect α_i estimates worker-invariant characteristics, while the residual ε_{it} represents the idiosyncratic noise affecting measured performance in a given month. The empirical distributions of both α_i and ε_{it} are approximately normal.

[TABLE 2]

First, consistent with the model's assumption regarding the ramp-up period, Table 2 shows that workers become more productive with tenure. Credited business generally rises most rapidly for new recruits and then decelerates, presumably as salespeople accumulate basic skills and develop a sales

[19] Specifically, $\ln y_{it}$ is the logged sum of the salesperson's split order credit– the credit value of transations multiplied by the share credited to the individual salesperson. The split order credit is the elemental unit of measured performance.

pipeline. Recall that this is a necessary condition to yield the model's predictions; intuitively, managers may expect an experienced, poor-performing incumbent with a mature pipeline to outperform a new recruit.

Second, Table 2 reports variation in workers' performance α_i controlling for tenure. The hypotheses concern workers who are revealed to be low ability by sustained low performance; for the remainder of the paper, I denote workers in the bottom quartile as "poor performers." Intuitively, these are the workers who have the bottom-quartile credited sales for workers of their job classification and tenure. Even if this method misclassifies the ability of some workers due to unobserved factors, it may offer a better-approximation of the supervisor's beliefs. Because poor performers have higher turnover, workers with bottom quartile $alpha_i$ values represent 25% of workers but only 18% of worker-months.

Lastly, Table 2 reports variation in a workers' period-specific "luck" ε_{it}. Depending on the industry, the worker fixed effect explains 70% to 88% of the variation in measured performance after controlling for tenure. Because this table aggregates to the industry level, it overstates the variation by worker effects compared to when the regression model is run for any job classification within a firm.

Conditional managerial quota attainments, Q_i^H and Q_i^L. Following Equation 5, define $Q_i^H \equiv Q_i^L + y_i$, where Q_i^L is the expected quota attainment if the poor performing subordinate turns over in the fourth fiscal quarter (months 10 - 12), y_i is the subordinate's contribution in the fourth quarter,[20] and their sum is the manager's expected quota attainment if the subordinate is retained in the fourth quarter.

To estimate Q_i^L, I recalculate the manager's quota attainment under the counterfactual scenario that subordinate i's sales in the fourth quarter are set to zero. This includes actual sales for the full fiscal year of all of the subordinate's peers under the same manager, plus the actual sales for fiscal months 1 - 9 for subordinate i.

To estimate Q_i^H, first I re-estimate the firm-job regressions in equation 8 with fiscal month fixed effects. Exponentiating the predicted values yields a prediction for sales credit in months of the fourth quarter that adjusts for fiscal month effects and subordinate i's prior performance. These values are then summed to estimate predicted sales in the fourth quarter, $y_i = \hat{y}_{i10} + \hat{Y}_{i11} + \hat{Y}_{i12}$. This prediction is strictly positive (following from exponentiating the logged dependent variable), and the difference between the logged predicted sales and the logged actual sales credit for those

[20] Note that y_i is the sum of the three y_{it}'s corresponding to months of the fourth quarter.

who stay is approximately normal with mean zero. Then $Q_i^H = Q_{iy}^L + \hat{y}_{i10} + \hat{y}_{i11} + \hat{Y}_{i12}$, where $\hat{y}_{im}$ is the exponentiated predicted values from the regression in month m. Note that I use the anterior predicted sales rather than actual sales even when actual sales are revealed in the data. I do this because the independent variable of interest is the manager's expectations, and because actual sales aren't observed for workers who turn over.[21]

Peer effects, the manager's private information, and other factors introduce measurement error into Q_i^L and Q_i^H. However, the power of the test is that it occurs at an interval, and so measurement error would lead to attenuation bias, reducing the likelihood of finding a significant result.

Defining Turnover. The data treat turnover events as any severance in employment for the purpose of recordkeeping within the SPM software. As such, turnover events include quits, layoffs, and fires. Turnover events also include internal job transfers to a position not covered by the SPM software, but do not include transfers to a position covered by or added to the SPM software. For example, a salesperson who transfers within sales or who is promoted to a sales manager is likely to remain in the data (and therefore not be counted as a termination). However, a salesperson who transfers out of sales may drop out of the data and be counted as a turnover event. Data include 38,159 turnover events and 15,695 internal transfers.

[FIGURE 3]

Figure 3 shows turnover over the fiscal year. A few features deserve note. First, turnover in these data is high compared to other occupations; overall annualized turnover is 47%. Along with the great variation in sales performance, this statistic provides a sense of the importance of selection and screening in this setting. Second, there is great periodicity in turnover within quarters and within the fiscal year. This provides a sense of the importance of the fiscal year in the tempo of turnover. Third, turnover is slightly higher and less periodic among poor performers. Typically, poor performers are screened at defined measurement periods, and high performers often leave after collecting their bonuses, and poor performers have greater overall churn.

The reasons for turnover (terminations or quits) are immaterial in this setting, since it distinguishes the likelihood of turnover inside the "treatment bubble" where the manager has a personal interest in retaining the worker. In doing so, the identification strategy also solves a problem for research on turnover, since the distinction between terminations and quits is often

[21] As a check, I compare predicted sales against actual sales among retained subordinates, and confirm that actual log-sales are approximately normally distributed with mean zero about predicted log-sales.

blurry; workers who would be fired are often counselled to quit, and workers who quit may have instead been persuaded by enticements to stay.

IV. Results

A. Results for Managerial Quotas and Subordinates' Staffing

To test Hypothesis 1, I test whether the turnover of "quota-critical" poor-performing subordinates in the fourth quarter (*i.e.* $Q_i^L < 100\% < Q_i^H$) is lower than the turnover for poor performers for managers whom the model predicts would or would not meet a quota anyway (*i.e.* $100\% < Q_i^L < Q_i^H$ or $Q_i^L < Q_i^H < 100\%$). To test the specific hypothesis that turnover is delayed for a month, rather than foregone, I also test whether the turnover of quota-critical poor performers in Month 13 is higher than non-quota critical poor performers.

[TABLE 3]

Consistent with Hypothesis 1, Table 3 shows that turnover is 5.6% when the manager reaches the quota threshold if and only if the subordinate's credited transactions are counted, substantially lower than the 18.6% turnover rate when the manager does not meet quota (H1a) and the 22.2% turnover rate when the manager would meet quota anyway (H1b). Both differences are significant with $p < 0.01$. These results suggest managers forego terminating poor performers late in the measurement period when these subordinates are needed for the manager to meet quota. Table 3 also shows that "thirteenth month" turnover among poor-performing subordinates is substantially higher when the manager met quota but would not have without the subordinates' fourth quarter credited transactions, compared to managers who did not meet quota (H1c) or would have met quota anyway (H1d). Taken together, results suggest managers delay terminating poor performers until the following fiscal year when doing so would reduce their likelihood of making an annual quota.

Although the result does not hold for non-poor performers, this result should be treated with caution. Most non-poor performers are making their quotas, suggesting that their performance is sufficient to avoid termination. The highest performers are likely to delay quitting until the end of the year to collect their bonus pay.[22]

[22]The data are generally consistent with this account. Only 31% of quotas among poor performers are met, and the median variable pay of poor performers (including team incentives) is only 4% of fourth quarter salary. In contrast, 60% of quotas among non-poor performers are met, 80% of non-poor performers receive variable pay in the fourth quarter, and the median variable pay

To provide an estimate for how much turnover among poor performing salespeople is foregone because the manager is near a quota threshold, I restrict the sample to the poor performing salespeople whose sales are not necessary for their managers to meet quota and perform a logistic regression predicting the likelihood a subordinate will turn over as a linear function of the manager's and subordinate's quota attainment. I compare this predicted likelihood to the actual turnover rates among salespeople whose sales were necessary for their managers to meet quota, and estimate that total actual fourth quarter turnover among poor performers is 15% (s.e.: 1%) less than it would be if turnover among these "quota-critical" salespeople followed the same linear trend.

[FIGURE 4]

To examine turnover rates in greater detail, Figure 4 presents fourth quarter turnover rates within 5% bins of the expected quota attainments when the subordinate turns over, Q_i^L, rather than retained, Q_i^H. Fourth quarter turnover of poor performers drops sharply when the model predicts the manager will barely make quota. The low turnover among poor-performing subordinates whose managers who (barely) didn't need the subordinate to meet quota suggests managers may be conservative in terminations.

As a robustness check against effects and common shocks occurring at the level of the industry, the level of the firm, and the level of the manager's peers, I compare turnover rates of subordinates' against the quota attainment of a manager who shares the same upper-manager as their own direct manager. Intuitively, if managers are thought of as the "parent" position in the organizational hierarchy, subordinates may be compared against the quota attainment of the manager filling their "uncle" position.

[FIGURE 5]

Figure 5's presents two series of data. The hollow markers show the turnover rates at the uncle's quota attainment levels for the universe of their "niece/nephew" subordinates. The solid markers restrict the sample to subordinates outside the treatment bubble of the parent position. This is important, since the parent's and uncle's quota attainments are not independent. The hollow series shows that the turnover among poor performers in the neighborhood of the uncle's quota exhibits a small dip, which is not as pronounced as it is around the parent's quota. Turnover within 10% of

among non-poor performers is 60% of base salary. For this reason, the primary incentive for improving performance among non-poor performers may be increasing variable pay, while the primary incentive among poor performers may be avoiding dismissal.

the uncle's quota is 2.4% (with a standard error of 0.3%) lower than it is within 50% of the uncle's quota. The restriction introduced in the solid markers eliminates statistically significant effects in the neighborhood of the uncle's quota threshold, suggesting the dip among the hollow markers is caused by correlation in the uncle and parent's quota attainment.

Results show turnover among poor performers is lower late in annual measurement periods when poor performers' credited transactions would affect whether the manager would meet quota, and greater in the following month. More broadly, results suggest managers delay terminating poor performers until the following fiscal year when doing so is likely to affect their perceived likelihood of making quota. By showing that the parent position's quota attainment predicts turnover net of the "uncle" position's quota attainment, I rule out common shocks at the level of industry, firm, or division within the firm (at the next level of the organizational hierarchy).

B. Results for Managerial Quotas and Subordinates' Incentives

To test the hypothesis that managers' quotas affect their subordinates' incentives, I test whether subordinates are more likely to have their quotas adjusted just prior to the end of the fiscal year when the manager is in the neighborhood of making a quota.

I run six logistic regressions to evaluate the likelihood of quota adjustments over months of the fourth quarter, as a function of the manager's and subordinate's ultimate quota attainment. These regressions take the form

$$\ln\left(\frac{\hat{p}}{1-\hat{p}}\right) = \hat{\beta}_0 + \mathbf{X}'_m\hat{\beta}^m + \mathbf{X}'_s\hat{\beta}^s \tag{10}$$

where $\hat{p}$ is the logit-estimated probability for the outcome of interest, $\mathbf{X}'_m$ is a dummy vector indicating the 5% quota attainment bin of the manager and $\mathbf{X}'_s$ is a dummy vector indicating the 5% quota attainment bin of the subordinate. This regression is performed for the six outcomes of interest corresponding to {Upward Adjustment, Downward Adjustment} $\times$ {Month 10, Month 11, Month 12}.

[TABLE 4]

[FIGURE 6]

Table 4 shows the logistic regression results for downward adjustments in Months 10, 11, and 12. Figure 6 illustrates the regression's estimated probabilities at the manager's and subordinate's ultimate quota attainments, holding the other's constant at their mean, for both upward and

downward adjustments for each month.

Before discussing the main results, some trends deserve note. First, downward adjustments are more common than upward adjustments. Upward adjustments, while potentially bad for morale, may adjust for an exogenous circumstance that boosts performance measures (*e.g.* a product launch) or may be implemented as a penalty (too many clients canceled sales). Second, the probability that quotas are adjusted downward in months ten and eleven declines slightly as the manager's quota attainment increases. This slight downward trend may be because when a manager has a high quota attainment, it suggests the subordinate's peers are doing well, and that the subordinate is responsible for poor sales and should not be awarded a downward quota adjustment. Third, the probability that quotas are adjusted downward in months ten and eleven are more-sensitive to the quota attainment of the subordinate. One explanation is that managers interpret greatly-surpassed quotas as a signal the quota is already too low (consistent with ratcheting models). Fourth, quota adjustments in months ten and eleventh are more likely to place subordinates in the neighborhood of ultimately reaching their quota, rather than far above or far below. Fifth, quota adjustments are both more-rare and less-sensitive to the manager's and subordinate's quota attainment in the twelfth fiscal month than they are in the tenth and eleventh fiscal months. Lastly, in addition to these general trends, subordinates throughout the distribution receive both downward and upward quota adjustments, including downward adjustments for salespeople who greatly surpass their quotas and upward adjustments for salespeople who greatly miss their quotas. This may be because adjusting one subordinate's quota may also require adjusting comparable peers' quotas as well, in the interest of fairness.

Table 4 and Figure 6 lend support for the main prediction. The regression estimates that the likelihood a subordinate receives a quota adjustment is significantly lower ($p < 0.05$) in each of the six 5% intervals of the manager's quotas between 75-90% and 110-125%, compared to the interval 100-105%, for both fiscal months 10 and 11. The jump in the probability of an adjustment in the neighborhood of quota attainment does not appear in the twelfth fiscal month. I do not find strong evidence that upward adjustments are more likely in the neighborhood of either a subordinate's or manager's quota threshold.

To provide an intuition of the magnitude, I restrict the sample to workers whose managers are not within 10% of making quota, re-estimate the likelihood of receiving a downward quota adjustment as a linear function of the manager's ultimate quota attainment, and compare the estimated likelihood of receiving a quota adjustment against the actual likelihood of receiving a quota adjustment among workers whose managers were within 10% of the quota threshold. These estimates suggest 13%

(s.e.: 1%) of downward quota adjustments in months 10 and 11 are explained by the jump in quota adjustments among managers within 10% of making quota.

The likelihood of quota adjustments in the tenth and eleventh months of the fiscal year rise in the neighborhood of making quota, but not more pronounced for those who barely-met a quota compared to those who barely-miss it. As such, subordinates are more-likely to receive downward adjustments when their managers will not meet a quota anyway. One interpretation is that quota adjustment is a blunt instrument for boosting sales. Channel stuffing, discounting, credit-trading, sales hoarding, and reallocating effort (both in quantity and toward deals near completion) may offer more-immediate and precise ways of making a quota.

V. Solutions to Managerial Gaming?

Results suggest sales functions' turnover and quota adjustments are different than what they would be in the absence of managers' discrete interest in making quotas. Presumably, there are profit-maximizing criteria for terminating poor performers and adjusting quotas, and these are distinct from manager's interest in the marginal sale associated with his or her quota attainment. Moreover, this study tests for a narrow, relatively well-identified gaming behavior; interviews suggest that pricing, channel stuffing, and gaming discretionary bonuses may be more costly to the firm. Agency and organizational theory provide some guidance as to how managerial gaming may be mitigated.

The model calls attention to at least four specific levers for reducing managerial gaming. First, firms may make efficient managerial actions incentive compatible by eliminating discrete incentives (setting $B = 0$). Second, firms may make staffing practices adjustments contractible on exogenous circumstances (conditing terminations on sales y_{it} given x_t). Although the model assumes is not possible since x_t is not observed by the firm, firms may require supervisors to justify their decisions by verifying x_t, if possible. Third, firms may make managerial actions contractible through monitoring (same as above, but randomly auditing and punishing managers who do not follow this rule). Fourth, firms may attempt to make managers interested directly in the well-being of the firm, aligning managers interests with those of the firm.

Indeed, each solution has imperfect real world analogues in sales hierarchies' actual practices. Respectively, firms may start commission payments below 100% quota attainment, avoid discrete bonuses at quotas, or otherwise deemphasize discrete thresholds. Firms use forecasting to estimate what a competent salesperson's performance should be, given their position. Firms use internal auditing, reporting, and bureaucratic rules to monitor managers. Firms use selective recruitment

and invest in company culture to promote commitment.

Some potential solutions are less obvious, and receive little treatment in the literature. A first class of solutions emerges from the organization of work. First, the benefits of territory-specific skills and networks are small, firms may assign leads from a shared pool rather than assign territories from a partition of a larger market. If leads are distributed randomly (or the quality distribution is otherwise known), then individuals may be assessed on a level playing field with peers. Second, if territories are maintained, firms may identify the quality of the territory by job rotations. These would allow firms to compare newcommers across incumbents.

These devices for identifying poor performers are akin to identification strategies used in the social sciences. However, firms may be retiscent to implement such devices due to technological obstacles on their part, or due to distrust among salespeople of complicated and untransparent plans. Sales organizations increasingly invest in technology to improve forecasts, to adjust based on exogenous circumstances, to make performance measurement criteria transparent and visible to salespeople, and to improve transparency in decision-making. As such, technology and complementary employment practices may allow organizations to align local incentives, identify sales ability, and discourage gaming.

A second class of solutions revolves around promoting identification with the firm. In sales industries where high variable pay is common, salespeople are notoriously driven by commissions rather than company loyalty. However, behavioral research and examples from industry may offer methods for mitigating gaming behavior.[23]

VI. Conclusion

This study examines the imperfect ability of organizational hierarchies to motivate intermediary managers to act on the organization's behalf. It does so by exploiting the fact (itself treated as exogenous) sales managers have a discrete interest in meeting a quota, that these quotas are reached through transactions completed largely through subordinates, and that marginal pecuniary incentives for the subordinates completing these transactions are generally distinct from their managers at the manager's quota threshold. Because an incumbent poor performer with accumulated job-specific skills and an established sales pipeline is likely to be more productive in the short term than a new recruit, sales managers may pull in sales by retaining poor performers until

[23]Here, the long organizational literature on promoting and rewarding organizational citizenship behavior may provide insight (see, for example, Podsakoff et al. 2009 for a review). SAS Corporation and Apple serve as famous examples as companies that have enjoyed high sales performance and sales team loyalty without commissions.

the following fiscal year. Because incentives for salespeople far below quota are weak, adjustments that make quotas "within reach" allow managers to boost immediate sales, while risking future moral hazard and disillusionment as adjustments become expected and viewed as entitlements. Following the model, I propose firms delegate authority for these decisions to managers due to their private knowledge of salespeoples' abilities and the sales environment, which is difficult for the firm to observe and verify. Although piecerates encourage mangers to use this information to improve the screening and motivation of the salesforce, discrete quotas and sales goals provide managers an incentive to game the staffing and incentives of subordinates. This study makes three main contributions.

First, this study makes a methodological contribution by testing hypotheses using on-demand sales performance management software, which creates standardized, reliable, longitudinal, cross-firm data. These data enable the study of compensation plans and performance for a large number of workers while mitigating the habitual selection issues and external validity concerns of studies in which participating firms "opt-in." Although these data are not amenable to "insider econometrics" within any particular firm, it complements its birds-eye perspective of sales with interviews from managers and compensation consultants with inter-industry sales experience.

Third, this study contributes a theory for the delegation of authority in organizational hierarchies, inspired by the institutional details of managing sales. Using a firm-supervisor-worker model, I hypothesize that firms use managerial incentives to make terminating low ability workers incentive compatible, since a firm cannot fully contract on a worker's ability or the difficulty of the selling environment. I show how firms attempt to use the many theoretical solutions to managing gaming, including the practices of monitoring, reporting, incentives, bureaucratic rules, job rotations, and attempts to get workers to identify with the firm. I use organizational and agency theory to inform the conditions under which these practices may be effective.

Second, this study contributes well-identified evidence for a specific failure of agency intermediation. While both classic and recent theoretical work emphasizes misalignment of managerial incentives in determining the structure of the firm, the empirical evidence has focused on inefficient pursuits of self-interest among chief executives' accounting decisions and rank-and-file workers' allocation of effort, rather than decisions affecting immediate subordinates directly. This study uses agency theory to distinguish a "treatment bubble" in which the manager has a particularly high interest in boosting sales, and uses the data to show how retention and incentive adjustments distinguished for subordinates inside this bubble. As such, this study corroborates the classic hypothesis that the interests of managers, who are the intermediary agents responsible for

perfoming the activities of the firm, are inconsistent with profit maximization.

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TABLE 1— Descriptive Statistics by Industry

	Information & Enterprise Software	Scientific, Professional, & Technical Services	Manu-facturing	Other
	(1)	(2)	(3)	(4)
a. Basic Descriptives				
Firms	56	38	62	88
Firm-Months	1,032	679	1,165	1,693
Persons	18,662	14,448	22,297	13,920
Person-Months	286k	237k	330k	160k
b. Standardized Jobs				
Sales Managers	1,960	1,658	2,139	1,883
Sales Reps	4,028	5,255	6,829	3,686
Account Managers	2,227	2,239	2,174	2,332
Other	12,159	8,207	12,238	6,689
c. Orders & Payments				
Transactions	23m	22m	74m	37m
Commissions	15m	14m	39m	30m
Bonus Payments	49k	47k	176k	86k
Other V. Payments	14k	6k	54k	116k
Var. Pay (USD)	2,277m	1,462m	3,729m	1,523m
d. Key Variables				
Turnover Events	8,968	3,170	9,346	7,909
Comp Plans	1,877	1,052	1,842	1,126
Quotas	28,702	21,087	32,006	19,175
EE-Fiscal Years	35,703	30,472	44,461	23,982

NOTE – Firms include all those for which data are complete. "Other" industries include retail trade (14 firms), wholesale trade (13), administrative support (12), and finance and insurance (10). The suffix "m" denotes the count is in millions. Data include 89 private and 133 public companies and subsidiaries thereof. Sales managers include persons with reporting subordinates. Credited transactions include only unique order-worker combinations, and do not count, for example, annuity tails or redundant individual/team credits. Other variable payments include, for example, draws that are arguably part of base pay.

TABLE 2— OLS Spline Regression Predicting Log-Credited Business of Subordinate Employees with Employee Fixed Effects, by Industry

	Information & Enterprise Software	Scientific, Professional, & Technical Services	Manu-facturing	Other
	(1)	(2)	(3)	(4)
Months 1 - 3 (M_3)	0.281*	0.132*	0.268*	0.217*
	(0.014)	(0.015)	(0.011)	(0.016)
Months 4 - 6 (M_6)	0.157*	0.125*	0.162*	0.166*
	(0.006)	(0.006)	(0.005)	(0.007)
Months 7 - 9 (M_9)	0.136*	0.020*	0.070*	0.102*
	(0.004)	(0.003)	(0.003)	(0.004)
Months 10-12 (M_{12})	0.109*	0.018*	0.063*	0.0747*
	(0.003)	(0.003)	(0.002)	(0.003)
Months 13+ (M_{13})	-0.099*	0.002	0.009*	0.048*
	(0.002)	(0.001)	(0.001)	(0.002)
Constant	9.077*	6.766*	8.771*	6.846*
	(0.030)	(0.029)	(0.023)	(0.034)
SD of α_i	4.794	6.359	3.999	5.503
SD of ε_{it}	3.066	2.415	2.522	2.429
Share of var($\ln y_{it}$) explained by α_i	0.710	0.874	0.715	0.837
Fixed Effects (EEs)	11,397	10,961	8,314	7,864
Obs (EE-Months)	141,493	91,373	168,101	69,383

NOTE – $*: p < 0.01$. These regressions are performed at the level of four industries, while distinguish poor performers use regressions at the level of 834 job-firm combinations, where employee fixed-effects are normalized such that employee fixed effects for jobs-in-firms have a mean of zero. Regression results are for workers without subordinates who ultimately had greater than six months tenure and who had at least four peers with their firm-job category.

TABLE 3— Monthly Turnover by Estimated Quota Attainment With and Without Subordinate's Credits, for Poor and Non-Poor Performing Subordinates

Parent's Q Attainment		$Q_i^H < 100\%$	$Q_i^H \geq 100\%$	$Q_i^H \geq 100\%$
Discounted Q Attainment		$Q_i^L < 100\%$	$Q_i^L < 100\%$	$Q_i^L \geq 100\%$
Outcome of Parent's Q Attainment vis Sub.:		"Misses Quota Anyway"	"Makes Quota Conditionally"	"Makes Quota Anyway"
		(1)	(2)	(3)
a. Poor Performing Subordinates				
Fourth Quarter	mean	18.6%	5.6%	22.2%
	s.e.	(0.69%)	(0.36%)	(0.35%)
	n	3,114	3,972	13,853
"Month 13"	mean	7.4%	14.4%	4.1%
	s.e.	(0.53%)	(0.61%)	(0.19%)
	n	2,427	3,306	10,137
b. All Other Subsordinates				
Fourth Quarter	mean	10.4%	11.1%	18.8%
	s.e.	(0.30%)	(0.32%)	(0.16%)
	n	9,857	9,133	56,887
"Month 13"	mean	3.7%	4.7%	1.5%
	s.e.	(0.22%)	(0.25%)	(0.05%)
	n	6,946	6,862	45,358

NOTE – Turnover rates are for subordinates in the fourth quarter and the first month of the year following the fiscal year for which the manager's quota attainments and the subordinate-adjusted quota attainments are reported. "Month 13" results include only cases where the manager-worker pair matches across fiscal years (*i.e.* neither the manager nor subordinate were transferred, the manager did not turnover, and the subordinate did not turn over in the previous quarter).

TABLE 4— Logit Predicting Subordinate's Quota Adjustment by Manager's and Subordinate's Realized Quota Attainment, for Fiscal Months 10 - 12

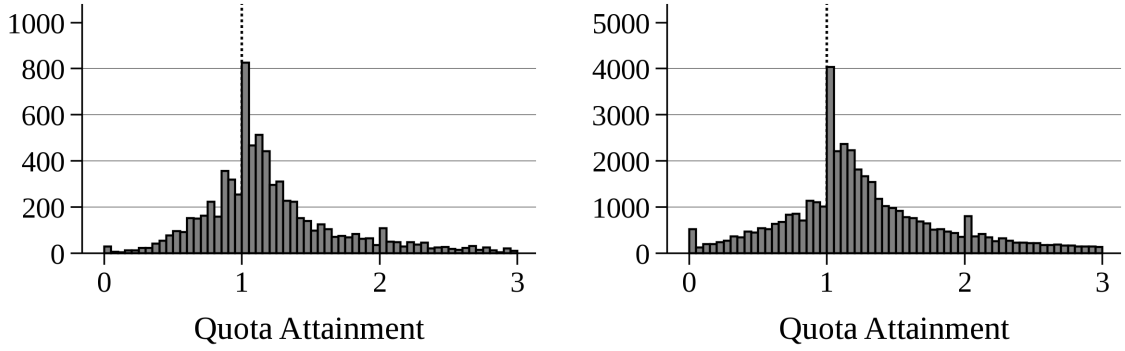
	Month 10 (1)		Month 11 (2)		Month 12 (3)	
	β^m	β^s	β^m	β^s	β^m	β^s
75-80%	-0.437**	-0.525*	-0.395*	-0.317*	0.137	0.104
	(0.151)	(0.157)	(0.166)	(0.139)	(0.242)	(0.183)
80-85%	-0.587*	-0.180	-0.582*	-0.206	0.093	-0.271
	(0.148)	(0.133)	(0.163)	(0.130)	(0.206)	(0.194)
90-95%	-0.331**	-0.425**	-0.439**	-0.346**	0.119	0.0451
	(0.123)	(0.128)	(0.136)	(0.116)	(0.194)	(0.157)
95-100%	-0.189	0.212*	-0.022	0.024	0.114	0.021
	(0.119)	(0.108)	(0.121)	(0.106)	(0.238)	(0.161)
100-105%	ref	ref	ref	ref	ref	ref
105-110%	0.012	0.184*	-0.009	-0.057	0.022	-0.103
	(0.084)	(0.087)	(0.091)	(0.085)	(0.178)	(0.133)
110-115%	-0.364**	-0.190	-0.321**	-0.381**	0.531**	0.0243
	(0.092)	(0.097)	(0.099)	(0.094)	(0.174)	(0.134)
115-120%	-0.465**	-0.217*	-0.398**	-0.523**	0.217	-0.086
	(0.087)	(0.090)	(0.092)	(0.088)	(0.171)	(0.127)
120-125%	-0.473**	-0.274**	-0.565**	-0.506**	0.045	-0.183
	(0.098)	(0.104)	(0.107)	(0.097)	(0.183)	(0.141)
Exterior 5% F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-2.096*		-2.213*		-2.923*	
	(0.070)		(0.075)		(0.158)	
Obs.	41,665		41,090		38,228	

NOTE – ** : $p < 0.01$, * : $p < 0.05$. Each logit regression spans two columns. Includes manager-subordinate pairs in which both ultimate quota attainments are within 50% of quota. Exterior controls include 5% quota attainment bins (shown in the accompanying figure). Standard errors clustered by the manager-worker pair.

FIGURE 1. : Histogram of Business Credit, by Rank and by Incentive (Quotas with Bonuses, Quotas without Bonuses, and Commission-Only)

a. Managers

b. Subordinates



NOTE – Histograms represent counts of realized total quota attainment (at 5% intervals) at the end of annual measurement periods among salespeople and sales managers employed over the entirety of the measurement period. All panels corresponding to managers include only plans with orders that are credited to at least four subordinates, who themselves do not have subordinates, and whose subordinates' sum of quotas are not within 5% of the manager's quota. The quartiles of the sum of subordinates' quotas are 50%, 100%, and 200% of the manager's quota, and only 7% of the sum of the subordinates quotas are exactly the manager's quota.

FIGURE 2. : Expected Payoffs: Retaining and Terminating Low Ability Workers

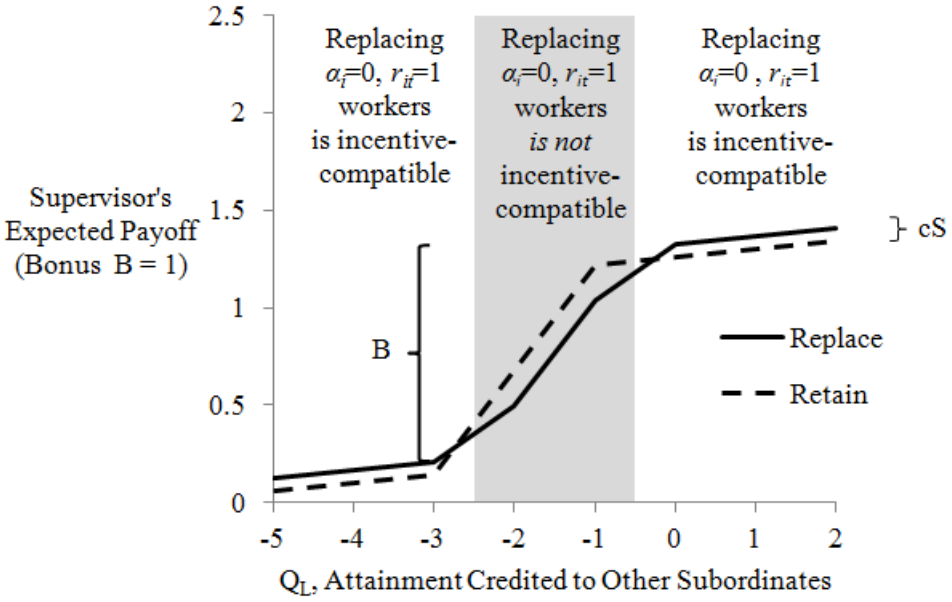
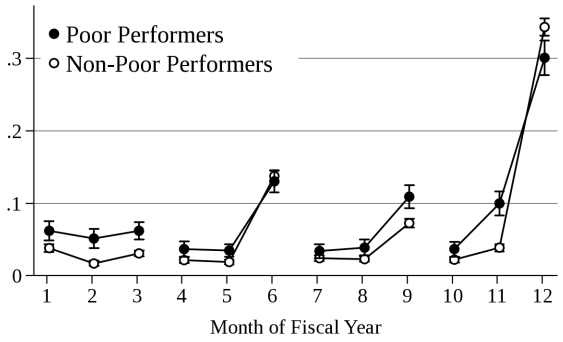


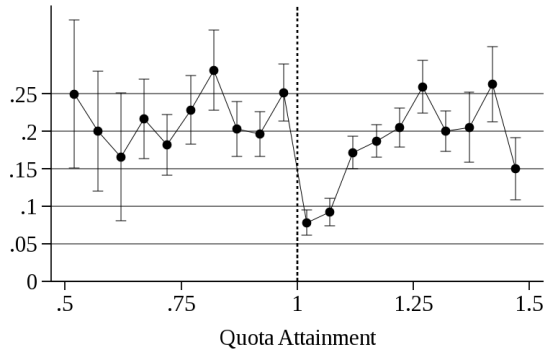
FIGURE 3. : Monthly Turnover over the Fiscal Year



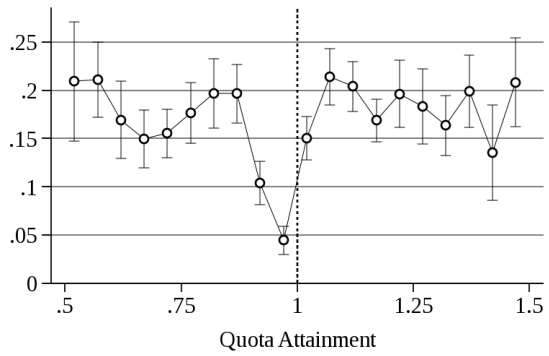
NOTE – Whiskers represent 95% confidence intervals.

FIGURE 4. : Turnover of Poor-Performing Subordinates at Managers' Quota Thresholds

a. Turnover by Expected Attainment if Subordinate i is Retained, Q_i^H

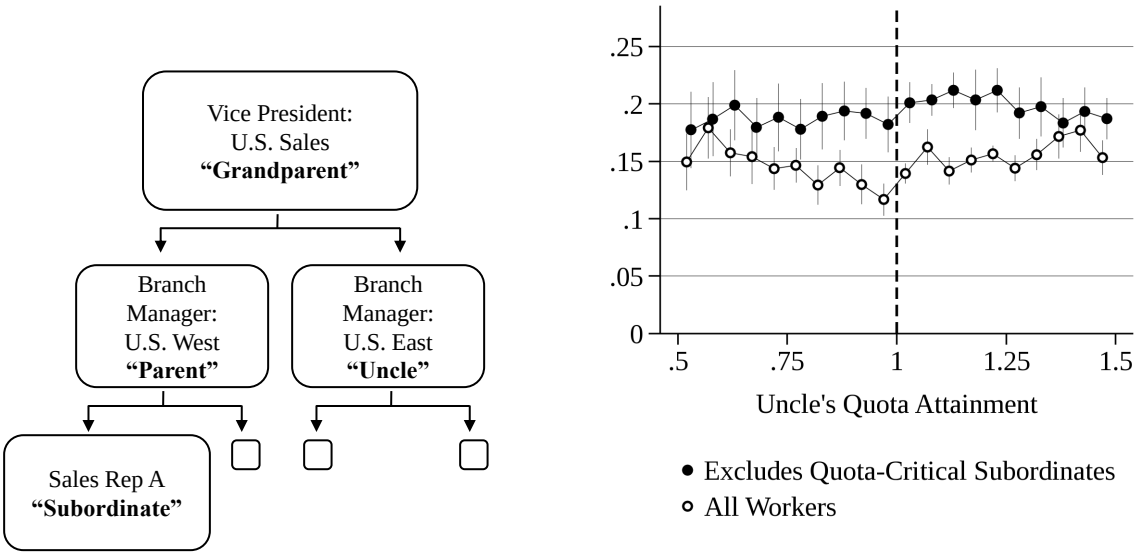


b. Turnover by Expected Attainment if Subordinate i Turns Over, Q_i^L



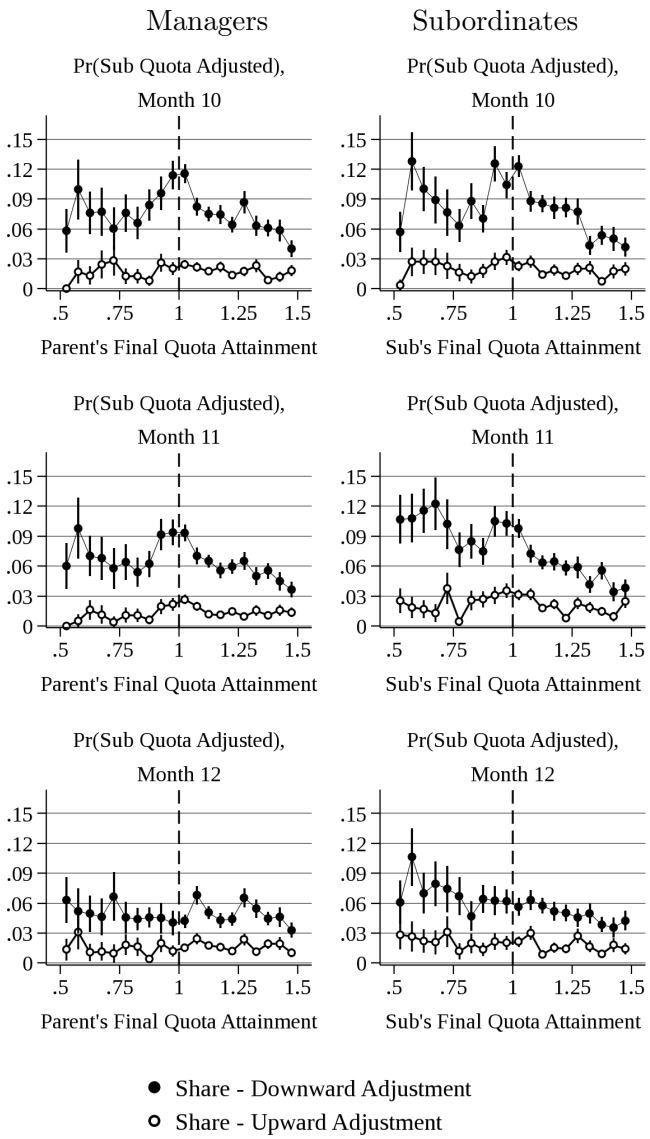
NOTE – Quota attainment is discretized into 5%-wide bins. Whiskers represent 95% confidence intervals.

FIGURE 5. : Turnover of Poor-Performing Subordinates at Uncle-Position's Quota Thresholds



NOTE – Among rank-and-file subordinates, I use "uncle" to denote a randomly-selected manager who reports to the subordinate's parent's parent ("grandparent"). Fewer than 1% of all subordinates have no "uncles."Solid markers omit workers whose sales were predicted to be critical to meeting the parent position's quota. Whiskers represent 95% intervals.

FIGURE 6. : Predicted Probabilities a Subordinate's Quota is Adjusted, by Manager's and Subordinate's Own Ultimate Quota Attainment



NOTE – Predicted probabilities by manager's quota are at mean values for subordinate quota attainment bins, and predicted probabilities by the subordinate's quota threshold are at the mean values for manager quota attainment bins. Quota attainment bins are post-adjustment. Whiskers represent standard errors.