

# Spiffed-Up Channels: The Role of Spiffs in Hierarchical Selling Organizations

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**W**e study a channel relationship in which manufacturer(s) use independent sales representatives (rep firms), which employ salespeople to do the actual selling. We show that commission-only payments by manufacturers to rep firms lead to suboptimal outcomes for the manufacturer relative to those obtained under a vertically integrated channel. From the manufacturer's standpoint, these inefficiencies can be ameliorated through the use of sales incentives given to the rep firm's salespeople directly by the manufacturer (called "spiffs").

In a monopolistic environment, spiffs are shown to improve the manufacturer's profits in the face of contractual restrictions on the channel members' ability to set separate commission rates by product. For certain types of restrictions, spiffs may generate manufacturer outcomes close to the fully coordinated ones achieved under vertical integration even when compensating the rep firm through commission-only contracts.

In a competitive environment, spiffs are shown to be used by a powerful manufacturer that shares a rep firm's sales efforts with the product of a weaker manufacturer (i.e., in the case of "common agency"). In this case, spiffs are used as a strategy to deter the weaker manufacturer from challenging the stronger manufacturer for the salesforce's valuable selling effort.

*Key words:* agency theory; channels of distribution; compensation; salesforce; competition

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## 1. Introduction

The use of independent sales representatives (rep firms) is a growing trend in the current business environment (Coughlan et al. 2006). In the 1970s, it was estimated that 50% of all manufacturers used rep firms exclusively or in combination with their own salesforces (Research Institute of America 1975). More recently, the National Association of Manufacturers completed a survey of its members in which 67% of the respondents indicated that they use rep firms. Moreover, among those using rep firms, 63% indicated that during the past three years they had either maintained or increased their use of rep firms (Manufacturer's Agents National Association (MANA) 2001b). Rep firms are used in a wide variety of companies and industries; Anderson and Trinkle (2005) list a number of companies that use rep firms, such as Ingersoll-Rand (air and electronic power tools), Avery Dennison (pressure-sensitive adhesives, office products), Master Lock Company (padlocks and security products), Kraft Foods (snacks, beverages, cheese, convenience foods), and Kimberly-Clark Corporation (health and hygiene products).

Rep firms are independent companies (which can have few or many salespeople in their employ) that

sell a set of products but do not perform physical possession, ownership, financing, risking, or other channel flows. A rep firm commonly covers a specific territory and specializes in a limited range of products. Typically, the line carried by a rep firm includes products from an array of manufacturers that may be unrelated or complementary in demand. Rep firms generally are compensated by their manufacturers with commission payments only, amounting to 5%–15% of a product's wholesale cost (Minority Business Development Agency (MBDA) 2003). Companies choose to use rep firms for a variety of reasons, among them the need to trim sales costs and fixed overhead, their own lack of expertise in dealing with different sales territories, and to gain access to an experienced, committed salesforce in local markets (Churchill et al. 1997, pp. 112–113; Novick 2000, pp. 30–34; MBDA 2003).

The use of a rep firm raises fundamental agency issues for a manufacturer. Even though a rep firm is a downstream channel member functioning as the manufacturer's sales organization, usually the manufacturer has very little control over the rep firm's salesforce. In contrast, a manufacturer with its own employee salesforce can exert greater control over

salespeoples' activities because the common organizational culture provides consistent values and norms (Heide and John 1992, MBDA 2003), and also because the vertically integrated manufacturer can implement a richer system of monitoring, rewards, and punishments to motivate the employee salesforce than if it used an independent rep firm's salesforce (Anderson 1985, Anderson and Oliver 1987, John and Weitz 1989).

The job of aligning incentives when using a rep firm is doubly challenging because of the need to align the incentives of both the rep firm's owner (hereafter called the "rep firm") and the rep firm's salespeople with the manufacturer's own goals. The challenge intensifies when commission rates are not customized by product at the manufacturer or rep firm levels, in cases where the products sold do not have the same demand characteristics. The business press literature illustrates that different types of representation contracts are used in the marketplace and that both individualized and single commission rates are currently used (Srikonda 2001, Electronics Representatives Association 2003). In personal interviews,<sup>1</sup> we found evidence from both manufacturers and rep firms of contracts involving common commissions across different products. For instance, in one rep firm that sold different forms of granite, the manufacturer (mining company) supplying the granite offered the firm the same commission rate for all grades of granite, even though some of the more rare and beautiful colors and patterns had different values as well as selling difficulties associated with them. In turn, the rep firm paid its salespeople the same commission on sales for every type of granite.

Government regulation or policies may also impose common commission rates. For example, the U.S. government's General Services Administration (GSA) specified that brokers yielding commissions from a carrier should propose a single commission rate to be used with all carriers selected by the broker to provide transportation and accessorial services under GSA's program (GSA 1997). In the insurance industry, some states<sup>2</sup> in the United States allow insurance companies to use only a single commission rate in the entire state for insurance products in the same risk rating tier. Following the European Treaty, the European Commission regulates European businesses so that companies cannot impose unfair purchase or trading conditions, exclusionary prices or

trading conditions, or dissimilar conditions for equivalent transactions.<sup>3</sup> These regulations force companies to employ commissions that stay in a "narrow" band. Labor regulations can also prevent a rep firm from discriminating between salespeople by offering different commission rates in different sales territories, creating one-commission-rate restrictions.<sup>4</sup>

These are important representative examples of various contractual limitations between the manufacturer and the rep firm, or between the rep firm and its salesforce, that can restrict the channel's ability to fit rewards to the specifics of various possible demand (or selling) situations. They are not the only ones to which our research could apply. Our work also speaks to the completely analogous case of how to set rep firm channel compensation for a single product through different periods of time, in situations where demand changes through time. For instance, the demand for many products is seasonal throughout a single year, yet compensation contracts are frequently reevaluated only annually (Mantrala et al. 1997). This situation does happen in the real world; for example, a former director of IBM reported that contracts with rep firms were renegotiated every 12 months, frequently with common commission rates across products, and no firm wanted to engage in mid-year renegotiations (interview with Steve Corio referenced above). A former rep firm owner, now a consultant to the industry, corroborated this pattern from the rep firm's perspective (interview with Bob Trinkle referenced above). This creates the same coordination and agency problem as those for two different products sold in the same period but facing different demands. Another possible interpretation of our research context is to the situation in which a single product is sold through a rep firm with two sales territories facing some sort of labor regulation preventing the firm from discriminating between salespeople by offering different commission rates in different sales territories (see the aforementioned Footnote 4).

These sorts of alternative interpretations describe realistic incentive problems faced by the manufacturer seeking to sell through a rep firm to the market; however, for simplicity of exposition henceforth, we use the first interpretation above.

Apparently in response to these coordination challenges when selling through a rep firm channel, some manufacturers employ a tool known as "spiiffs" (direct

<sup>1</sup> Sources include a personal interview with Steve Corio, former program manager of IBM and now a consultant in sales management, and a phone interview with Bob Trinkle, former owner of a rep firm and now a consultant to rep firms and the co-author of Anderson and Trinkle (2005).

<sup>2</sup> See, for instance, the New Jersey Statutes Annotated Code—Title 17B Insurance and the Texas Statutes—Insurance Code.

<sup>3</sup> See European Treaty, Article 82.

<sup>4</sup> See, for instance, Chapter 10 ("Compensation Discrimination") of the U.S. Equal Employment Opportunity Commission "Compliance Manual" (EEOC Directive Transmittal 911.003 of December 5, 2000). Casual observation says that there are other countries that enforce labor regulations as well.

incentives offered by the manufacturer to a rep firm's field salesforce, rather than to the rep firm itself). Spiffs can be used, for example, to give a new-to-the-market product an extra boost by increasing the time spent on selling it by the rep firm's field salesforce or to lift sales in the slow holiday season; one industry participant remarked on the incentive effect of spiffs by saying "competitive products at competitive commissions usually win the day, [but] carrier incentives and spiffs can often tip the scale on close deals" (Teal 2004). An article on using and managing sales reps explains regular commissions and spiffs this way (MANA 2001a, p. 44):

Commission rates...are determined by the marketplace. (...) There are situations where we believe higher than normal commission rates or special payment timing also result in win-win situations. One example is the need for missionary effort to either help a company get established in a territory where they have little presence or in the launching of a new product for a company already well-received in the territory. Substantially increasing the commission rate...allows the rep to more rapidly recover the cost of their missionary selling efforts. These special incentives should last for a sufficient time to allow reps to more rapidly recover their missionary effort costs. The added incentive also provides greater assurance to the manufacturer that prompt market penetration, so necessary for competitive advantage, is achieved.

The quote above demonstrates not only the common use of spiffs to alter a rep firm's salesforce's incentives to sell a specific product, but also the use of spiffs as a competitive tool. The appropriate length of time to let a spiff run depends on the market conditions and the desired outcome; while many believe spiffing is a short-term phenomenon, the evidence suggests that longer-term spiffs can also occur. One rep firm owner, familiar with spiffs granted by manufacturers to help launch new products, responded to an interviewer about the optimal length of spiffing by saying, "A minimum of six months is best, but the duration can also vary." Another rep, interviewed for the same article, said, "We don't get too excited about short-term incentives. We do, however, like long-term programs (one year or more) that reward a steady and consistent sales effort" (MANA 2001c, p. 35).

Indeed, if spiffs are so useful as tools to help solve the agency problem, an interesting question is why not use them more often or, indeed, all the time? This research recognizes both the continued use of spiffs in these channels and their apparent strategic value, and investigates when they are best used and under what market and demand circumstances they are (and are not) profitable tools to manage the rep firm channel.

Our work uses three major research streams as inputs. The first is the research in salesforce management, more specifically salesforce compensation

(see Coughlan and Sen 1989 and Coughlan 1993 for reviews of this literature). Early work such as Farley (1964), Farley and Weinberg (1975), and Srinivasan (1981) focused on the optimal multiproduct salesforce commission in a deterministic world. After the development of agency theory, research considered a world with stochastic sales and risk-averse salespeople. The work of Basu et al. (1985) models a single-product salesperson and, more recently, Lal and Srinivasan (1993) consider salesforce compensation plans for single- and multiproduct salesforces. Joseph and Thevaranjan (1998) study compensation incentives coupled with monitoring of selling agents, and Godes (2003) considers the effect of task complexity on the relative importance of salespeople selling skills. This literature considers only two-level hierarchical organizations consisting of a sales manager (the principal) and the salesforce (the agents). In most of these papers, compensation is the only instrument available to sales managers to align the salesforce's objectives with their own. Thus, while this work forms an important foundation for this research, it does not include all the key features of the agency problem when selling through a rep firm channel.

The second relevant research stream is the work in agency theory that considers multilayered organizations, including Baron and Besanko (1992), who investigate different hierarchical organizational structures and the implications of hidden communication; McAfee and McMillan (1995), who analyze the delegation of incentive contracts; and Melumad et al. (1995), who analyze the delegation of incentive contracts allowing the third party to be a productive agent as well. Other related work considers principal-supervisor-agent types of hierarchies and focuses on collusive behavior among supervisor and agents (as in Bernheim and Whinston 1986, Laffont and Tirole 1991, Kofman and Lawarree 1993, Laffont and Martimort 1998).

A third research stream of interest is the work in marketing channels, in particular the channel coordination literature. Much of this literature (such as Jeuland and Shugan 1983, 1988; Shugan 1985; Moorthy 1987) focuses on mechanisms such as quantity discounts and two-part tariffs to coordinate channel behavior. The work of McGuire and Staelin (1983) and Coughlan (1985) focuses on the profit division between retailer and manufacturers in a duopoly with substitute products and the resulting implications for equilibrium channel structure. Other authors, such as Ingene and Parry (1995, 2000) and Choi (1991), investigate different two-level hierarchical channel structures. Additional articles in this stream include the work of Moorthy (1988), who studies how strategic interaction with other manufacturers might affect manufacturers' channel structure decisions; and Lal (1990), who studies the role of

monitoring and incentives in coordinating franchising relationships. More recently, research in channels by Iyer and Villas-Boas (2003) and Raju and Zhang (2005) consider situations in which the manufacturer is not the dominant player.

While the above literature contributes to our understanding of independent salesforces management, a full understanding of the problem of coordinating an independent salesforce with the help of multiple instruments demands a new and integrated framework. Our research differs from the extant hierarchical agency literature because, in our model, the “supervisor” (in our terms, the rep firm) acts as a delegated firm with no incentive to collude with the salesforce. Further, our research looks at the expanded contracting mechanism, spiffs, as a tool to improve channel profit and coordination.

We develop a model in which manufacturers employ an independent selling organization (the rep firm) with a salesforce able to sell multiple products. We assume that the manufacturer(s) offer the standard commission-only compensation contract to the rep firm; given this, we evaluate the optimality of adding spiffs to the compensation scheme. We examine both monopolistic and oligopolistic (competing manufacturers) industry structures, considering both unrestricted (product-specific commissions) and restricted (common product commissions) contracting at the manufacturer-rep firm level and the rep firm-salesforce level. While it might seem restrictive to consider a model form where one or both channel members (manufacturer and rep firm) can offer only one common commission rate on both products sold, evidence previously presented shows that this is in fact not an uncommon occurrence. Given the evidence presented above, it is clear that both the case of product-specific commission rates and common commission rates reflect relevant real-world situations that deserve examination. Table 1 illustrates the scenarios considered by our model and indicates in which section of the paper each scenario is examined.

Our research provides many new insights. First, we determine the optimal commission rates manufacturers should offer the rep firms and show that even with

**Table 1** Overview of Research Scenarios

1. Joint profit maximization at the manufacturer level
Case 1A. Monopoly: Both the manufacturer and the rep firm can set independent commission rates for each product (§3.1).
Case 1B. Monopoly: Both the manufacturer and the rep firm can only set one rate (§3.2).
2. Oligopolistic competition
Case 2A. Competition: The manufacturers and the rep firm can set independent commission rates for each product (§4.1).
Case 2B. Competition: The manufacturers can set independent commission rates for each product, but the rep firm can only set one rate (§4.2).

these optimal commission rates, the rep firm earns some of the channel’s rents. Specifically, our analysis identifies that when contracts can accommodate individual commission rates for each product at all levels in the channel and/or can be instantaneously renegotiated to accommodate structural demand shifts, then spiffs are not a profit-enhancing tool. Spiffs play a significant role, however, when contracting is constrained. Our results show that a multiproduct manufacturer (to whom we will refer as a “monopolist” for expositional convenience henceforward) constrained to offer a common commission rate across multiple products optimally chooses to offer spiffs on the weaker product in order to improve salesforce effort on it. Spiffs might also be optimal in an oligopolistic situation as a defensive tool against competition. In contrast to the results with a multiproduct manufacturer, our results show that in a competitive situation where each firm sells one product through the same rep firm, it is the stronger product that is optimally spiffed, not the weaker one. The possibility of spiffs forces competitive manufacturers into a “prisoners’ dilemma” outcome in which the manufacturer with the most productive product has to provide spiffs on its product so as to deter the competing manufacturer from engaging in a spiffing war. The optimality of spiffs is thus shown to be conditional on competitive structure at the manufacturing level.

This research thus casts light not only on the effect of contract restrictions but also of competitive effects on optimal spiffing behavior.

The remainder of the paper is organized as follows. The next section presents the setup of the model. Section 3 studies the implications of the model in a monopolistic manufacturing environment, while §4 studies the case of competition. The paper concludes in §5 with a discussion of our results and directions for future research.

## 2. The Model

We consider a three-level marketing system in which up to two risk-neutral manufacturers (high-level principals) sell products through a hierarchical selling organization consisting of one risk-neutral rep firm (principal) and the risk-averse salespeople in the rep firm’s salesforce (agents).<sup>5</sup>

We allow for a nonexclusive distribution structure in which two products are sold. The two products might be sold through the rep firm by a monopolist or, in the case of manufacturing-level competition, each product is sold by a different manufacturer. In either case, the rep firm represents both products

<sup>5</sup> The two-product case can be extended to any finite number of manufacturers (products) but is sufficient to examine the problem at hand.

but, as is typical of rep firms, does not take title to either of them. Hence, the manufacturers fix product retail prices.<sup>6</sup> In what follows, we denote manufacturers by  $j \in J = \{1, 2\}$  and products by  $i \in I = \{1, 2\}$ . The products are assumed to be unrelated in demand but are nevertheless connected competitively through the competing demands of the two products for salespeople's selling effort. This assumption lets us focus on the incentive and coordination effects of the compensation plan without extraneous effects such as demand complementarity or substitutability altering the salesforce's selling effort decisions.<sup>7</sup>

The rep firm is compensated by manufacturer  $j$  through contractual payments  $w_j = \sum_{i \in I} y_{ij} x_{ij}$ , where  $x_{ij}$  is the realized sales output for that manufacturer's product and  $y_{ij}$  is the per-unit commission rate for each product. We denote  $\mathbf{y}$  as the vector of rep firm's commission rates from the manufacturers.

The rep firm employs a salesforce to effectively do the sales work. The rep firm's salespeople are assumed to be homogenous and have nonoverlapping territories. This permits us to treat the salesforce as a single representative salesperson<sup>8</sup> who is compensated by the rep firm through contractual payments  $s_{ij} = \sum_{i \in I} \sum_{j \in J} b_{ij} x_{ij} + A$ , where  $A$  is the salesperson's salary and  $b_{ij}$  are sales commissions paid by the rep firm on sales of each product (product  $i$  of manufacturer  $j$ ). We denote  $\mathbf{b}$  as the vector of sales commission rates from the rep firm.

Both linear and nonlinear compensation schemes are used in practice, but this research focuses on the linear plan because of its tractability and its consistency with previous literature that shows that linear plans may indeed be optimal (Holmstrom and Milgrom 1987). Furthermore, its wide use in the sales compensation and control literature (Holmstrom and Milgrom 1991, Hauser et al. 1994, Lal and Srinivasan 1993, Joseph and Thevaranjan 1998) allows a comparison of this paper's results with the extant literature.

To increase the rewards to selling effort, manufacturers may provide direct financial incentives (spiffs)  $d_{ij} = z_{ij} x_{ij}$  to the rep firm's salespeople, where  $z_{ij}$  are

spiffs on product  $i$  paid by manufacturer  $j$  to the rep firm's salespeople. We denote  $\mathbf{z}$  as the vector of spiffs.

The salesperson can exert (costly) effort  $e_{ij} \in \{L, H\}$  to affect the sales outcome, where  $L$  represents low effort and  $H$  represents high effort. High effort increases the probability of high sales; however, exerting effort implies a disutility  $C[\cdot]$  for the salesperson. We normalize  $C[L] = 0$  and  $C[H] = c$ .<sup>9</sup>

Sales are characterized by the stochastic density function  $f(x_{ij} | e_{ij}) = X_{ij}[e_{ij}] + \varepsilon$ , where  $\varepsilon$  is a random shock distributed normal with mean zero and variance  $\sigma^2$  ( $\varepsilon \sim \mathbf{N}(0, \sigma^2)$ ), and the deterministic component is given by the functions  $X_{ij}[\cdot]$ , where  $X_{ij}[L] = q_{ij}$  and  $X_{ij}[H] = q_{ij} + \Delta_{ij}$ . We can think of  $q_{ij}$  as the base sales level and  $\Delta_{ij}$  as the selling-effort productivity.<sup>10</sup> This specification implies that  $x_{ij}$  is a random variable distributed according to a density conditioned by the endogenous salesperson effort level  $e_{ij}$ . As is usual in agency theory, we assume that the manufacturer's incentive compatibility constraint is always satisfied, so that it is always optimal to induce high effort on both products.<sup>11</sup> This means that the marginal sales return is high enough to compensate for the salesperson's risk-adjusted cost of effort.

While sales are not known ex ante, all players have a common "belief" regarding the sales response function. Therefore, even though the rep firm and the manufacturers do not directly observe the salesperson's choice of effort, they can infer it (imperfectly) from the relation  $x_{ij} \sim f(x_{ij} | e_{ij})$ .

Theoretically, an agent can be punished by the principal if an unwanted outcome is obtained, thus diminishing the cost of compensating high outcomes and maximizing the principal's profits. In our model, we assume that the salesperson has limited liability for low sales outcomes and cannot be punished with a negative reward due to a low sales outcome ( $b_{ij} + z_{ij} \geq 0$ ). To simplify the notation further, we define  $\mathbb{B}_{ij}$  to be the set  $\{x \in \mathbb{R}: -z_{ij} \leq x < +\infty\}$  and  $\mathbb{B}$  to be the set  $\bigcap_{i,j} \mathbb{B}_{ij}$ .

We further assume that the salesperson's utility is separable in money and effort:

$$u = v \left[ \sum_{i \in I} \sum_{j \in J} (s_{ij} + d_{ij} - C[e_{ij}]) \right],$$

<sup>6</sup> "Prohibitions on resale price maintenance do not apply 'to restrictions on price to be charged by one who is in reality an agent of, not a buyer from, the manufacturer'" (Coughlan et al. 2006, pp. 387–388). The manufacturer therefore rightfully controls retail pricing when selling through a rep firm.

<sup>7</sup> Adding complementarity or substitutability (either through demand interactions or cost interactions) does not change the qualitative results regarding spiffs in a substantive way. Hence, to avoid unnecessary complexity, we exclude these effects in this paper. A full analysis of the impact of such interactions on our model is provided in a technical appendix entitled "Complementarity and Substitution Analysis," available from the *Marketing Science* website at <http://mktsci.pubs.informs.org> or directly from the authors.

<sup>8</sup> We abstract from issues associated with team selling and performance dependence among agents.

<sup>9</sup> Convexity of the cost functions (which naturally causes cost interactions equivalent to substitution) does not change the qualitative results of the model regarding spiffs. See the aforementioned "Complementarity and Substitution Analysis" document (Footnote 7).

<sup>10</sup> A high  $\Delta_{ij}$  implies that changes in effort level are associated with great changes in the expected sales of product  $i$  of firm  $j$ .

<sup>11</sup> The manufacturer's marginal cost of sales (product cost) enters in the determination of its own incentive compatibility constraint. Provided the manufacturer's marginal cost is lower than the return of inducing high sales, then the constraint is satisfied and the manufacturer does not need to consider its own marginal cost on determining optimal contractual terms.

where  $v[\cdot]$  is a risk-aversion function that follows the constant absolute risk aversion for income formulation:  $v[\alpha] = -e^{-r\alpha}$ , where  $r \geq 0$  is the risk-aversion parameter. Moreover, the salesperson is assumed to have a minimum utility level of  $m$ , which represents his opportunity cost for taking another job, or simply his utility for not working at all.

Using Pratt's (Pratt 1964) certainty-equivalent (CE) formulation, we can rewrite the salesperson's expected utility as

$$u = \sum_{i \in I} \sum_{j \in J} \left[ (b_{ij} + z_{ij}) X_{ij}[e_{ij}] - \frac{r\sigma^2}{2} (b_{ij} + z_{ij})^2 - C[e_{ij}] \right] + A. \quad (1)$$

The salesperson's optimal choice of effort that maximizes his utility is the same that maximizes the CE form of his expected utility.

Because the rep firm and the manufacturers are risk neutral, their respective profit functions are given by

$$\pi_R = \sum_{i \in I} \sum_{j \in J} (y_{ij} - b_{ij}) X_{ij}[e_{ij}] - A, \quad (2)$$

and

$$\pi_{M_j} = \sum_{i \in I} (1 - y_{ij} - z_{ij}) X_{ij}[e_{ij}]. \quad (3)$$

This model follows a traditional moral hazard game. In such a setup, the rep firm attempts to control the salesforce through its compensation decisions. Specifically, the games are played according to the stages listed below:

*Stage 1.* The manufacturer(s) offer a stochastic contract to the rep firm consisting of the commission rates ( $\mathbf{y}$ ) and simultaneously announce the spiffs strategy ( $\mathbf{z}$ ).

*Stage 2.* The rep firm accepts or refuses the contract.

*Stage 3.* The rep firm offers a stochastic labor contract composed of salary ( $A$ ) and the product commission rates ( $\mathbf{b}$ ) to the salesforce.

*Stage 4.* The salesforce accepts or refuses the contract.

*Stage 5.* Each salesperson chooses effort.

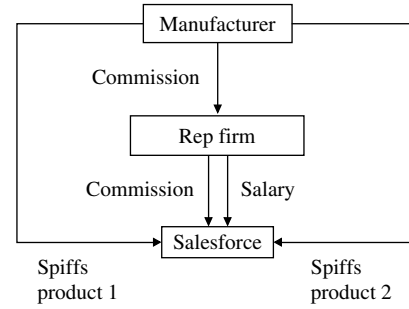
*Stage 6.* Outcomes are realized and compensation is awarded.

The next two sections analyze this model, considering first a joint profit maximization industry structure and then an oligopolistically competitive industry structure.

### 3. The Role of Spiffs in a Monopolistic Environment

To simplify our analysis, in this section we assume that just one manufacturer produces both products,

**Figure 1** Joint Profit Maximization Schema



which are therefore denoted product 1, 1 and product 2, 1. Because here the set of manufacturers  $J$  only has one element ( $j \in J = \{1\}$ ), we will drop the manufacturer index  $j$ .

This version of the model characterizes a monopolist selling two products with different selling-effort productivity at the same time, or can equivalently represent the case of a monopolist selling one product in two periods, with structural changes in demand in each period.

Figure 1 depicts the interaction among the players.

Before we proceed to analyze each case in the joint profit maximization environment, it is useful to discuss briefly the maximum system outcome that an integrated manufacturer and rep firm would expect to achieve in this monopolistic environment where the salesperson's effort is unobservable (detailed derivations are in the appendix).

**CLAIM 1.** *For the case of joint profit maximization, the expected maximum system outcome for the channel members when effort is unobservable is*

$$\pi_{\text{sys}}^{m,\text{max}} = (q_1 + \Delta_1 + q_2 + \Delta_2) - \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right) - 2c - m. \quad (4)$$

Expression (4) represents the fully coordinated channel outcome, i.e., the first-best result for the channel in a monopolistic environment. This expression means that the maximum outcome occurs when high sales outcome ( $q_1 + \Delta_1 + q_2 + \Delta_2$ ) is implemented at minimum cost, which in this situation is the sum of the salesperson's risk premium ( $r\sigma^2/2$ )( $c^2/\Delta_1^2 + c^2/\Delta_2^2$ ), the salesperson's disutility for effort  $2c$ , and the salesperson's minimum utility  $m$ . This outcome could be obtained through vertical integration of the manufacturer and the rep firm or through a two-part tariff contract.<sup>12</sup>

Notice that this expression also represents the maximum outcomes that either the monopolistic manufacturer or the rep firm could get in this environment,

<sup>12</sup> See Jeuland and Shugan (1988) for a discussion of two-part tariffs, vertical integration, and channel coordination.

which would occur when one of these players extracts all the rents from the system:  $\pi_M^{m,max} = \pi_{syst}^{m,max}$  when  $\pi_R = 0$ , and  $\pi_R^{m,max} = \pi_{syst}^{m,max}$  when  $\pi_M = 0$ .

Next, we proceed to analyze the equilibrium outcomes in the monopolistic rep firm channel.

### 3.1. The Baseline Unrestricted Monopoly Model (Case 1A)

Because in the real business environment the most widely used indirect sales compensation schemes in manufacturer-rep firm channels are pure-commission contracts, in this research we focus on commission-only contracts between the manufacturers and the rep firm. However, the salesforce is compensated by the rep firm through a salary-plus-commission scheme.

We proceed by considering the case of joint manufacturer profit maximization from the sale of two products with different sales response functions, when there are no restrictions on the ability of the manufacturer to set product-specific commissions to the rep firm, nor on the ability of the rep firm to set product-specific commissions to its salesforce.

The corresponding moral hazard problem is represented by the following optimization program:

$$(P^{m,free}): \max_{y, z \in \mathbb{R}_+} \sum_{i=1}^2 (1 - y_i - z_i) X_i[e_i]$$

subject to

$$RPC: \sum_{i=1}^2 (y_i - b_i) X_i[e_i] - A \geq 0$$

$$RIC: A, \mathbf{b} \in \arg \max_{A \in \mathbb{R}, b_i \in \mathbb{B}_i} \sum_{i=1}^2 (y_i - b_i) X_i[e_i] - A$$

subject to

$$SPC: \sum_{i=1}^2 \left[ (b_i + z_i) X_i[e_i] - \frac{r\sigma^2}{2} (b_i + z_i)^2 - C[e_i] \right] + A \geq m$$

$$SIC: \mathbf{e} \in \arg \max_{e_i \in [L, H]} \sum_{i=1}^2 \left[ (b_i + z_i) X_i[e_i] - \frac{r\sigma^2}{2} (b_i + z_i)^2 - C[e_i] \right] + A,$$

where *SPC* and *SIC* are, respectively, the participation constraint and incentive compatibility constraint for the salesperson and *RPC* and *RIC* are, respectively, the participation constraint and incentive compatibility constraint for the rep firm.

This problem is solved through backward induction: The rep firm, taking the compensation it gets from the manufacturer as given, sets salesforce compensation terms considering the salesperson's optimization problem and participation constraint. The manufacturer acts as a Stackelberg leader, setting compensation terms to the rep firm considering the

rep firm's optimized behavior rule and participation constraint.

The following proposition characterizes the equilibrium arising in this model.

**PROPOSITION 1.** *For the case of joint manufacturer profit maximization, when contracts can accommodate compensation rates for every individual product both at the manufacturer and at the rep firm level, spiffs do not change the outcome for any player and hence there is no need for spiffs.*

*In this case, the optimal rep firm contract to its salesforce entails:*

$$b_1^{m,free} = \frac{c}{\Delta_1}, \quad b_2^{m,free} = \frac{c}{\Delta_2}, \quad (5)$$

$$A^{m,free} = m + 2c - \left(\frac{c}{\Delta_1}\right)(q_1 + \Delta_1) - \left(\frac{c}{\Delta_2}\right)(q_2 + \Delta_2) + \frac{r\sigma^2}{2} \left(\frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2}\right). \quad (6)$$

*The optimal manufacturer contract to the rep firm and salesforce entails:*

$$y_1^{m,free} = \frac{c(c(r\sigma^2/2) + \Delta_1^2)}{\Delta_1^3},$$

$$y_2^{m,free} = \frac{c(c(r\sigma^2/2) + \Delta_2^2)}{\Delta_2^3}, \quad (7)$$

$$z_1^{m,free} = z_2^{m,free} = 0. \quad (8)$$

*Manufacturer profits in equilibrium are:*

$$\pi_M^{m,free} = \left[ 1 - \frac{c(c(r\sigma^2/2) + \Delta_1^2)}{\Delta_1^3} \right] (q_1 + \Delta_1) + \left[ 1 - \frac{c(c(r\sigma^2/2) + \Delta_2^2)}{\Delta_2^3} \right] (q_2 + \Delta_2). \quad (9)$$

*Rep firm profits in equilibrium are:*

$$\pi_R^{m,free} = \frac{c(c(r\sigma^2/2) + \Delta_1^2)}{\Delta_1^3} (q_1 + \Delta_1) + \frac{c(c(r\sigma^2/2) + \Delta_2^2)}{\Delta_2^3} (q_2 + \Delta_2) - \frac{r\sigma^2}{2} \left(\frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2}\right) - 2c - m. \quad (10)$$

**PROOF.** See the appendix.  $\square$

Because the rep firm can specify the salesperson's salary plus independent commission rates for each product, it can induce the salesperson to exert high effort in both tasks, providing the salesperson no more than the necessary incentives associated with each task ( $c/\Delta_i$  for task  $i$ ), and adjusting the salary so that the salesperson retains only her minimum utility.

The manufacturer also can specify distinct rep firm commission rates for each product. However, because the rep firm never passes on the totality of the received commission to the salesperson, the manufacturer needs to pay a larger commission on sales of each product ( $c(c(r\sigma^2/2) + \Delta_i^2)/\Delta_i^3 = c^2r\sigma^2/(2\Delta_i^3) + c/\Delta_i > c/\Delta_i$  for product  $i$ ) than if it were able to contract with the salesperson directly.

Part of this difference in commissions ( $y_i^{m\_free} - b_i^{m\_free} = c^2r\sigma^2/2\Delta_i^3$ ) is captured by the rep firm, which is able to extract rents from the system according to expression (10) because of its position as employer of the valued resource: salespeople.<sup>13</sup>

In this scenario, spiffs cannot improve the manufacturer's situation because the rep firm would react to any spiffs offered by a manufacturer to the salesforce by reducing the previously optimal salesforce commissions by exactly the same value. The manufacturer would, in turn, also reduce the commission it pays to the rep firm by the same value, generating no difference in the final outcome. Therefore, because no outcome improvement is obtained by any player, spiffs have no function here, and the manufacturer will choose not to use this promotional tool.

The total outcome of the channel, given by  $\pi_M^{m\_free} + \pi_R^{m\_free}$ , is

$$\pi_{syst}^{m\_free} = (q_1 + \Delta_1 + q_2 + \Delta_2) - \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right) - 2c - m,$$

which means that in this case the *system* (albeit not the manufacturer alone) achieves the maximum outcome ( $\pi_{syst}^{m\_free} = \pi_{syst}^{m\_max}$ ).

This scenario is not "first best" from the manufacturer's point of view because it allows the rep firm to keep some rents. Our next analysis shows that contractual restrictions on the ability to offer product-specific commission rates can distort the channel outcome further, leaving the manufacturer in an even worse situation in a pure commission-based channel compensation structure. This creates a positive role for spiffs in restoring the channel outcome to the coordinated level and moving the manufacturer's outcome close to the theoretical optimum.

### 3.2. The Role of Contract Restrictions in a Monopoly (Case 1B)

Departing from the basic model structure presented above, in this subsection we examine the impact of restrictions that prevent individualized compensation

rates by product both at the manufacturer and at the rep firm level. As discussed in the Introduction, a common commission rate across two products with different demand characteristics can represent contracting situations restricted by industry factors or structurally different sales response functions.

In this case, the manufacturer's problem is very similar to ( $P^{m\_free}$ ), the difference being that the manufacturer and the rep firm commissions are common across products:

$$(P^{m\_spiff}): \max_{y, z \in \mathbb{R}_+} \sum_{i=1}^2 (1 - y - z_i) X_i[e_i],$$

subject to

$$RPC: \sum_{i=1}^2 (y - b) X_i[e_i] - A \geq 0$$

$$RIC: A, b \in \arg \max_{A \in \mathbb{R}, b \in \mathbb{B}} \sum_{i=1}^2 (y - b) X_i[e_i] - A$$

subject to

$$SPC: \sum_{i=1}^2 \left[ (b + z_i) X_i[e_i] - \frac{r\sigma^2}{2} (b + z_i)^2 - C[e_i] \right] + A \geq m$$

$$SIC: \mathbf{e} \in \arg \max_{e_i \in \{L, H\}} \sum_{i=1}^2 \left[ (b + z_i) X_i[e_i] - \frac{r\sigma^2}{2} (b + z_i)^2 - C[e_i] \right] + A.$$

Note, however, that it is possible to offer distinct spiff rates ( $z_i$ ) by product. The solution method to this problem is similar to that used to solve ( $P^{m\_free}$ ). The following proposition characterizes the equilibrium outcome for this problem, assuming that the product indexed by  $i = 1$  exhibits the greater selling-effort productivity ( $\Delta_1 > \Delta_2$ ).

**PROPOSITION 2.** *For the case of joint manufacturer profit maximization, when neither the manufacturer nor the rep firm contracts can accommodate different compensation rates for every individual product, spiffs are used in equilibrium. Moreover, only the product with lower selling-effort productivity (lower  $\Delta_i$ ) receives spiffs.*

*In this case, the optimal rep firm contract to its salesforce entails*

$$b^{m\_spiff} = \frac{c}{\Delta_1}, \quad (11)$$

$$A^{m\_spiff} = m + 2c - \left( \frac{c}{\Delta_1} \right) (q_1 + \Delta_1) - \left( \frac{c}{\Delta_2} \right) (q_2 + \Delta_2) + \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right). \quad (12)$$

<sup>13</sup> While it might appear that the rep firm adds no concrete value to the selling process in this model, in fact it serves the manufacturer well by screening local sales talent and giving access to high-quality sales effort. The rents it earns can thus be viewed as its return on the scarce resource of local market knowledge about salesforce talent.



The optimal manufacturer contract to the rep firm and salesforce entails

$$y^{m\_spiff} = \frac{c(cr\sigma^2 + \Delta_1\Delta_2 + \Delta_2^2)}{\Delta_1\Delta_2(\Delta_1 + \Delta_2)}, \quad (13)$$

$$z^{m\_spiff} = \left\{ 0, \frac{c}{\Delta_2} - \frac{c}{\Delta_1} \right\}.$$

Manufacturer profits in equilibrium are

$$\pi_M^{m\_spiff} = \left[ 1 - \frac{c(cr\sigma^2 + \Delta_1\Delta_2 + \Delta_2^2)}{\Delta_1\Delta_2(\Delta_1 + \Delta_2)} \right] (q_1 + \Delta_1 + q_2 + \Delta_2) - \left( \frac{c}{\Delta_2} - \frac{c}{\Delta_1} \right) (q_2 + \Delta_2). \quad (14)$$

Rep firm profits in equilibrium are

$$\pi_R^{m\_spiff} = \frac{c(cr\sigma^2 + \Delta_1\Delta_2 + \Delta_2^2)}{\Delta_1\Delta_2(\Delta_1 + \Delta_2)} (q_1 + \Delta_1 + q_2 + \Delta_2) + \left( \frac{c}{\Delta_2} - \frac{c}{\Delta_1} \right) (q_2 + \Delta_2) - \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right) - 2c - m. \quad (15)$$

PROOF See the appendix.  $\square$

Productive tasks (i.e., sales effort on product 1) do not need high incentives to be implemented. Conversely, low productivity tasks (i.e., sales effort on product 2) need high incentives to be implemented. Because the two products are subject to the same commission rate but have different productivities of selling effort, to induce high effort on *both* products in the absence of spiffs, the rep firm would need to provide to the salesperson a commission rate incentive that implements high effort on the *least* productive of the tasks (which in this case would be  $c/\Delta_2$ , because  $c/\Delta_2 = \max\{c/\Delta_1, c/\Delta_2\}$ ). Consequently, the manufacturer would also need to provide strong enough incentives (i.e., a high enough common commission  $y$  to the rep firm) so that the sales structure would lead to high effort on the less productive of the tasks. Without the use of spiffs, this (common) commission rate exceeds the level that would be necessary to induce high effort on the product with higher selling-effort productivity. This would not only distort total channel profit downward, but would also allow the rep firm to increase rent extraction by capturing most of the difference in incentives between the two tasks (see the proof of Proposition 2 for the mathematical details).

Therefore, in the absence of spiffs, the common-commission contract restrictions increase the rep firm's profitability at the expense of the manufacturer's profitability; thus, the manufacturer has to use other tools to better align the selling organization and reduce the distortion. The use of spiffs meet this need.

However, spiffs are not necessary for all products. By providing spiffs only on the low selling-effort productivity product, the manufacturer can make the salesperson perceive the two tasks to be equally rewarding, so the manufacturer can be assured that the smaller rep firm commission that induces high effort on selling the high-productivity product also results in high selling effort on the low-productivity product.

This strategy allows the manufacturer to extract most of the rents from the system by specifying a common manufacturer's commission for both products that induces the rep firm to set a salesperson commission just sufficient to induce high sales effort on the high-productivity product—while additionally using a spiff on the low-productivity product to increase its attractiveness just enough to induce high selling effort on it as well.

This rent extraction result is driven by the fact that the optimal spiff level forces the rep firm into a situation in which it cannot set the salesperson's commission rate to implement one of the tasks (achieving high sales of the high-productivity product) without implementing the other task (achieving high sales of the low-productivity product as well). This puts the rep firm in a situation in which it has only two options: to induce low sales effort for both products, or high sales effort for both products. Indeed, given optimal spiffing, the manufacturer saves money on commissions paid to the rep firm. Without spiffs, the manufacturer in effect overpays the rep firm. In contrast, the manufacturer who uses a spiff on the product with lower selling-effort productivity lowers its commission bill to the rep firm on *both* products. An additional savings to the manufacturer comes from the fact that a spiff is paid directly to the rep firm's salesperson and hence bypasses the rep firm (with its private incentive to extract channel rents).

To see this, notice from Equation (11) that the optimal rep firm commission (for both tasks) is  $b^{m\_spiffs} = c/\Delta_1$ , which is the commission that implements high effort for the high-productivity product. Notice also that this commission plus spiffs for the low-productivity product is  $b^{m\_spiffs} + z_2^{m\_spiffs} = c/\Delta_1 + c/\Delta_2 - c/\Delta_1 = c/\Delta_2$ , which is sufficient to implement high effort in this product as well.<sup>14</sup>

The total outcome of the channel, given by  $\pi_M^{m\_spiff} + \pi_R^{m\_spiff}$  is

$$\pi_{\text{sys}}^{m\_spiff} = (q_1 + \Delta_1 + q_2 + \Delta_2) - \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right) - 2c - m,$$

<sup>14</sup> Notice that if both products have the same selling-effort productivity ( $\Delta_1 = \Delta_2$ ), spiffs do not arise because  $z_2^{m\_spiff} = c/\Delta_2 - c/\Delta_1 = 0$ . Also, spiffs would not arise if there were only one product.

which means that in this case the channel also achieves the maximum system outcome ( $\pi_{\text{sys}}^{o\text{-spiff}} = \pi_{\text{sys}}^{m\text{-max}}$ ). However, this result is reached only with the use of spiffs. One can see from the proof of Proposition 2 that without the use of spiffs, not only would the system outcome be smaller, but

$$\pi_{\text{sys}}^{m\text{-no}} = (q_1 + \Delta_1 + q_2 + \Delta_2) - r\sigma^2 \left( \frac{c^2}{\Delta_2^2} \right) - 2c - m,$$

implying a difference in the total outcome of  $\pi_{\text{sys}}^{o\text{-spiff}} - \pi_{\text{sys}}^{m\text{-no}} = (r\sigma^2/2)(c^2/\Delta_2^2 - c^2/\Delta_1^2)$ , but also the rep firm would be able to extract more rents from the manufacturer, implying a double burden on the manufacturer. Therefore, it is clear that spiffs restore the channel outcome back to coordinated levels. This also allows the manufacturer's profit to move close to its "first-best" level.

In fact, through the use of spiffs, the manufacturer's profit gets closer to the maximum system outcome than it did when there were no restrictions on the compensation structures. By subtracting expression (9) from expression (14), we obtain the difference:

$$\begin{aligned} \pi_M^{m\text{-spiff}} - \pi_M^{m\text{-free}} &= \frac{r\sigma^2}{2} \frac{\Delta_1 - \Delta_2}{\Delta_1 + \Delta_2} \left( \frac{q_2 + \Delta_2 + 2q_2\Delta_2^2}{\Delta_2^3} - \frac{q_1 + \Delta_1 + 2q_1\Delta_1^2}{\Delta_1^3} \right), \end{aligned}$$

which is generally positive (unless  $q_1$  is much larger than  $q_2$ ), implying that the manufacturer's profits in this constrained case are higher than those in the unconstrained case.

Finally, we can see in the proof of Proposition 2 that the manufacturer does better with spiffs ( $\pi_M^{m\text{-spiff}} > \pi_M^{m\text{-no}}$ ), while the rep firm does better without spiffs ( $\pi_R^{o\text{-spiff}} > \pi_R^{o\text{-no}}$ ).

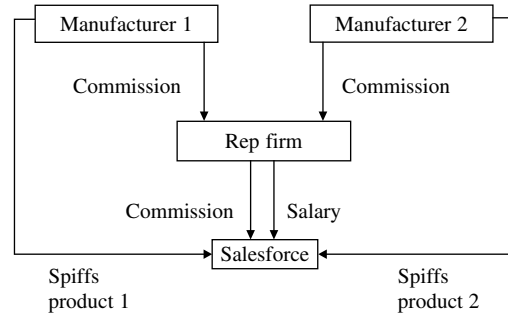
## 4. The Role of Spiffs in a Competitive Environment

In this section, we introduce competition and study the role of spiffs in a manufacturing-level oligopoly. We assume that there are two independent manufacturers, with manufacturer 1 producing product 1, 1 and manufacturer 2 producing product 2, 2. To simplify notation, we will drop the product index  $i$  and use the index  $j$  to refer to both the manufacturer and the manufacturer's product. The stages of the game are the same as in §2, except for Stage 1, which is modified to include Nash competition between the two manufacturers.

Figure 2 depicts the interaction among the players.

Before we proceed to analyze each case in the oligopoly environment, it is useful to recall from Claim 1 that the maximum system outcome that the

**Figure 2** Competition (Oligopoly) Schema



channel members could possibly obtain in this environment is

$$\begin{aligned} \pi_{\text{sys}}^{o\text{-max}} = \pi_{\text{sys}}^{m\text{-max}} &= (q_1 + \Delta_1 + q_2 + \Delta_2) \\ &- \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right) - 2c - m. \end{aligned} \quad (16)$$

Expression (16) is the first-best result for the channel in an oligopolistic environment. This expression holds when all members act as an integrated firm, and the explanation for the terms can be found on the discussion of Claim 1.

Next, we proceed to analyze the equilibrium outcomes in the oligopolistic rep firm channel. The first case we studied in the manufacturer joint profit maximization industry structure (Case 1A) can be easily translated to the oligopolistic industry structure (Case 2A) and yields similar results. The second case (Case 1B), however, cannot be simply translated to the oligopolistic industry context (Case 2B) since the introduction of competition produces completely different results.

### 4.1. The Baseline Unrestricted Oligopolistic Model (Case 2A)

In this case, each manufacturer can set a distinct commission for its product to the rep firm, and the rep firm can also offer product-specific commissions to the salesperson.

The next proposition characterizes the results in this oligopolistic environment.

**PROPOSITION 3.** *For the case of oligopoly competition, when contracts can accommodate compensation rates for each individual product both at the manufacturer and at the rep firm level, spiffs do not change the outcome for any player and hence spiffs are not used in equilibrium. Furthermore, equilibrium contractual provisions are the same as those in the monopoly situation (Case 1A).*

*In this case, the optimal rep firm contract to its salesforce entails*

$$\mathbf{b}^{o\text{-free}} = \left\{ \frac{c}{\Delta_1}, \frac{c}{\Delta_2} \right\}, \quad (17)$$

$$A^{o\_free} = m + 2c - \left(\frac{c}{\Delta_1}\right)(q_1 + \Delta_1) - \left(\frac{c}{\Delta_2}\right)(q_2 + \Delta_2) + \frac{r\sigma^2}{2} \left(\frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2}\right). \quad (18)$$

The optimal manufacturer contract to the rep firm entails

$$y_j^{o\_free} = \frac{c(c(r\sigma^2/2) + \Delta_j^2)}{\Delta_j^3}, \quad \text{for } j = 1, 2, \quad (19)$$

$$z_j^{o\_free} = 0, \quad \text{for } j = 1, 2. \quad (20)$$

The manufacturer's profits in equilibrium are

$$\pi_{Mj}^{o\_free} = \left[1 - \frac{c(c(r\sigma^2/2) + \Delta_j^2)}{\Delta_j^3}\right](q_j + \Delta_j), \quad \text{for } j = 1, 2. \quad (21)$$

Rep firm profits in equilibrium are

$$\begin{aligned} \pi_R^{o\_free} &= \frac{c(c(r\sigma^2/2) + \Delta_1^2)}{\Delta_1^3}(q_1 + \Delta_1) \\ &+ \frac{c(c(r\sigma^2/2) + \Delta_2^2)}{\Delta_2^3}(q_2 + \Delta_2) \\ &- \frac{r\sigma^2}{2} \left(\frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2}\right) - 2c - m. \end{aligned} \quad (22)$$

PROOF. Mathematically, the manufacturer's problem is very similar to the monopolistic problem ( $P^{m\_free}$ ). The difference is that the profits for the manufacturers are not a summation of terms, but just the profit from selling one product. The solution follows the steps in the proof of Proposition 1 and yields similar expressions.  $\square$

The above proposition implies that when commission rates can be customized by product both at the manufacturer and at the rep firm level, competition is not an issue for any of the players. Contractual provisions obtained in this situation are the same as those obtained in the unrestricted joint profit maximization case, and thus spiffs are not profit enhancing.

In this case, the total channel outcome, given by  $\pi_{M1}^{o\_free} + \pi_{M2}^{o\_free} + \pi_R^{o\_free}$ , is

$$\pi_{\text{sys}}^{o\_free} = (q_1 + \Delta_1 + q_2 + \Delta_2) - \frac{r\sigma^2}{2} \left(\frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2}\right) - 2c - m,$$

which means that the channel achieves the maximum system outcome ( $\pi_{\text{sys}}^{o\_free} = \pi_{\text{sys}}^{o\_max}$ ).

Although the competitive environment outcome is the same as the monopolistic one under contract flexibility, we will see in the next subsection that competition has a strong effect when contract flexibility is relaxed.

## 4.2. Competition and the Role of Contract Restrictions (Case 2B)

Departing from the basic model structure presented above, in this subsection we examine the impact of restrictions that prevent individualized compensation rates at the rep firm level. Because each manufacturer has only one product, the commission rate restriction does not affect the manufacturers.

Following the same basic structure in the previous unconstrained oligopolistic problem ( $P^{o\_free}$ ), we construct the oligopolistic problem ( $P^{o\_spiff}$ ) by restricting the salesforce commission to a single rate:

$$(P^{o\_spiff}): \max_{y_j, z_j \in \mathbb{R}_+} (1 - y_j - z_j)X_j[e_j], \quad \text{for } j \in \{1, 2\}$$

subject to

$$\text{RPC: } \sum_{j=1}^2 (y_j - b)X_j[e_j] - A \geq 0$$

$$\text{RIC: } A, b \in \arg \max_{A \in \mathbb{R}, b \in \mathbb{B}} \sum_{j=1}^2 (y_j - b)X_j[e_j] - A$$

subject to

$$\text{SPC: } \sum_{j=1}^2 \left[ (b + z_j)X_j[e_j] - \frac{r\sigma^2}{2}(b + z_j)^2 - C[e_j] \right] + A \geq m$$

$$\begin{aligned} \text{SIC: } \mathbf{e} \in \arg \max_{e_j \in \{L, H\}} \sum_{j=1}^2 \left[ (b + z_j)X_j[e_j] \right. \\ \left. - \frac{r\sigma^2}{2}(b + z_j)^2 - C[e_j] \right] + A. \end{aligned}$$

Up to the rep firm level, the oligopolistic problem ( $P^{o\_spiff}$ ) is the same as the monopolistic problem ( $P^{m\_spiff}$ ) and yields the same form of results. At the manufacturers' level, however, the restrictions on the rep firm contract cause a strategic interaction that intensifies manufacturer competition.

The following proposition characterizes the equilibrium arising in this model, assuming that the product indexed by  $j = 1$  exhibits the greater productivity of selling effort ( $\Delta_1 > \Delta_2$ ).

PROPOSITION 4. *For the case of oligopoly competition, when each competing manufacturer can offer an individualized commission rate for its product to the rep firm but the rep firm is constrained to offer a common commission rate on both products to its salesforce, spiffs are used in equilibrium. Moreover, only the product with higher selling-effort productivity (higher  $\Delta_j$ ) receives spiffs.*

*In this case, the optimal rep firm contract to its salesforce entails*

$$b^{o\_free} = \frac{c}{\Delta_2}, \quad (23)$$

$$A^{o\_free} = m + 2c - \left( \frac{c}{\Delta_2} + z_1^{o\_spiff} \right) (q_1 + \Delta_1) - \left( \frac{c}{\Delta_2} \right) \cdot (q_2 + \Delta_2) + \frac{r\sigma^2}{2} \left[ \left( \frac{c}{\Delta_2} + z_1^{o\_spiff} \right)^2 + \frac{c^2}{\Delta_2^2} \right]. \quad (24)$$

The optimal manufacturer contract to the rep firm entails

$$y_1^{o\_spiff} = 0, \quad y_2^{o\_spiff} = \frac{c[\Delta_1(\Delta_1 + \Delta_2) + cr\sigma^2]}{\Delta_1[\Delta_2(\Delta_1 + \Delta_2) - cr\sigma^2]}, \quad (25)$$

$$z_1^{o\_spiff} = \frac{c[\Delta_2^2(\Delta_1 + \Delta_2) + cr\sigma^2\Delta_1]}{\Delta_1\Delta_2[\Delta_2(\Delta_1 + \Delta_2) - cr\sigma^2]}, \quad z_2^{o\_spiff} = 0. \quad (26)$$

The manufacturers' profits in equilibrium are

$$\begin{aligned} \pi_{M1}^{o\_spiff} &= (1 - z_1^{o\_spiff})(q_1 + \Delta_1), \\ \pi_{M2}^{o\_spiff} &= (1 - y_2^{o\_spiff})(q_2 + \Delta_2). \end{aligned} \quad (27)$$

Rep firm profits in equilibrium are

$$\begin{aligned} \pi_R^{o\_spiff} &= (q_1 + \Delta_1)z_1^{o\_spiff} + (q_2 + \Delta_2)y_2^{o\_spiff} \\ &\quad - \frac{r\sigma^2}{2} \left[ \left( \frac{c}{\Delta_2} + z_1^{o\_spiff} \right)^2 + \frac{c^2}{\Delta_2^2} \right] - 2c - m. \end{aligned} \quad (28)$$

PROOF. See the appendix.  $\square$

Similar to the monopoly case in which the rep firm only had one commission rate to the salesperson (Case 1B in Table 1), the rep firm finds itself trapped by the single commission rate and cannot make the salesperson work hard on selling the less rewarding product ( $j = 2$ ) without providing more than necessary incentives in the more rewarding product ( $j = 1$ ).

Therefore, in absence of spiffs, the manufacturer with the higher selling-effort productivity product (manufacturer 1) would benefit enormously because it could easily win attention from the salesforce and, in fact, would be able to free ride on the other manufacturer's payment to the rep firm: manufacturer 1 could provide the minimal commission (which in this theoretical case is zero) and still be assured of high attention from the salesforce, thus shifting to the other manufacturer a double burden if it wants its product to receive high effort.

The possibility of spiffs, however, changes this situation. When spiffs are allowed, the manufacturer with the small selling-effort productivity product (manufacturer 2) would be inclined to provide spiffs in an attempt to make the salesforce perceive its product as the most rewarding and thus become the "free rider" manufacturer (thus shifting the double burden back to manufacturer 1).

To prevent this, manufacturer 1 itself has to provide spiffs so as to avoid losing the privileged position of having the most rewarding product. This triggers a "competition in spiffs" effect in which both manufacturers compete to provide higher and higher spiffs to the rep firm's salesforce.

However, manufacturer 2 cannot win the spiffing war because manufacturer 1 can always provide the same spiffs rate and be the one receiving the (almost) free salesforce attention. In fact, manufacturer 1 does not even need to match the other manufacturer to be perceived as having the most rewarding product. The proof of Proposition 2 shows that spiffs on the low selling-effort productivity product would need to be higher than the spiffs on the high selling-effort productivity product in order for the former product to become the most rewarding (the salesperson will have the same incentive to exert high effort on either product when  $z_2 = z_1(\Delta_1/\Delta_2) + b((\Delta_1 - \Delta_2)/\Delta_2)$ ).

An equilibrium is reached when manufacturer 1 provides the exact amount of spiffs that makes the other manufacturer indifferent between providing spiffs or not. In effect, this is manufacturer 1's "competitive spiff deterrence" rate, in the same sense that the competitive strategy literature talks about entry-detering strategies of strong incumbent firms. Hence, even if manufacturer 1 could free ride completely in a world without spiffs, when spiffs are possible it has to incur spiffing costs to preserve its favored status in the eyes of the rep firm's salesforce.

The total profit of the channel, given by  $\pi_{M1}^{o\_spiff} + \pi_{M2}^{o\_spiff} + \pi_R^{o\_spiff}$ , is

$$\begin{aligned} \pi_{syst}^{o\_spiff} &= (q_1 + \Delta_1 + q_2 + \Delta_2) \\ &\quad - \frac{r\sigma^2}{2} \left[ \left( \frac{c}{\Delta_2} + z_1^{o\_spiff} \right)^2 + \frac{c^2}{\Delta_2^2} \right] - 2c - m. \end{aligned}$$

It is easy to see that because  $(c/\Delta_2 + z_1^{o\_spiff})^2$  is clearly greater than  $c^2/\Delta_2^2$ , the channel system does not achieve the maximum system outcome and thus  $\pi_{syst}^{o\_spiff} < \pi_{syst}^{o\_free} = \pi_{syst}^{o\_max}$ . Moreover, the proof of Proposition 4 establishes that without the use of spiffs, the channel outcome would be

$$\pi_{syst}^{o\_no} = (q_1 + \Delta_1 + q_2 + \Delta_2) - r\sigma^2 \left( \frac{c^2}{\Delta_2^2} \right) - 2c - m,$$

which would imply that channel profits are lower with spiffing than without:

$$\pi_{syst}^{o\_spiff} - \pi_{syst}^{o\_no} = -\frac{r\sigma^2}{2} \left[ \left( \frac{c}{\Delta_2} + z_1^{o\_spiff} \right)^2 - \frac{c^2}{\Delta_2^2} \right] < 0.$$

Furthermore, we can see in the proof of Proposition 4 that manufacturer 1 does better without spiffs ( $\pi_{M1}^{o\_spiff} < \pi_{M1}^{o\_no}$ ) and that manufacturer 2 does better with spiffs ( $\pi_{M2}^{o\_spiff} > \pi_{M2}^{o\_no}$ ). We can also see that the rep firm's profitability depends on the baseline sales levels  $q_1$  and  $q_2$ . In general, when  $q_1$  is significantly larger than  $q_2$ , then  $\pi_R^{o\_spiff} - \pi_R^{o\_no} > 0$ . Conversely, when  $q_2$  is significantly larger than  $q_1$ , then  $\pi_R^{o\_spiff} - \pi_R^{o\_no} < 0$ .

In sum, in a competitive environment, spiffs move the channel further away from coordinated levels. This is a function of the fact that in this competitive environment the manufacturer with the highest selling-effort productivity product injects more money into the system (in the form of spiff funding). Part of this extra money benefits the competing manufacturer and might benefit the rep firm. The remaining part, however, is dissipated as a result of channel inefficiencies causing a further downward distortion in total channel profits.

## 5. Discussion and Conclusion

When the manufacturer(s) and their rep firm(s) are free to set individualized commission rates for each product (Cases 1A and 2A in Table 1), sales commissions alone are enough to help the channel achieve the first-best outcome and thus spiffs have no function from the channel standpoint. From the manufacturer(s) standpoint, this result is not first best because customized commissions allow the rep firm to extract economic rents from the manufacturing level. Normally, one would expect the manufacturer(s) to respond to this profit threat by using spiffs, but this is not possible since the rep firm can counteract any spiffing action by the manufacturer(s) through adjustment of the commissions it pays to its salespeople. Therefore, spiffs have no productive function from the perspective of the manufacturer(s) and will not be used.

However, when there are restrictions that force the rep firm (and perhaps the manufacturer) to only use a single commission rate (Cases 1B and 2B in Table 1), commissions alone are not sufficient to help the channel achieve the first-best outcome and thus the use of spiffs will endogenously emerge.

In a *monopoly manufacturing situation*, if spiffs are not used, contractual restrictions both decrease total channel performance and benefit the rep firm by increasing its rent extraction opportunity. This harms the manufacturer, which suffers not only the burden of decreased channel profits but also the burden of more rent extraction by the rep firm. However, if spiffs are allowed, the manufacturer can use them not only to restore the maximum system outcome but also to extract more rents from the rep firm. In fact, the manufacturer can extract even more rents in this situation than with product-specific commissions suggesting that a manufacturer actually welcomes such contractual restrictions if it can also use spiffs.

On the other hand, in a *competitive manufacturing situation*, if spiffs are not used, contractual restrictions also decrease total channel profits in the absence of spiffs. However, these restrictions greatly increase profits of the manufacturer with the highest selling-effort productivity product, which may free ride

on the competing manufacturer. Consequently, the manufacturer with the least selling-effort productivity product suffers a very heavy burden from these restrictions.

However, if spiffs are allowed, the manufacturer selling the highest-productivity product optimally spiffs enough to deter spiffs competition from the other manufacturer. This distorts system profitability further downward. In addition, the manufacturer with the most productive product does not benefit from “free riding” as much as it did before, because it has to inject money into the channel through spiffs. Part of this money is recouped by the other manufacturer that now does not need to pay a huge commission to motivate high salesforce effort on its product. The rep firm might also capture some of this money, depending on the characteristics of the sales response functions. The remaining part is dissipated due to the inefficiency in contracting between the rep firm and its the salesforce.

These results suggest the following testable predictions:

- With contracting flexibility (individualized or adjustable commission rates are possible), manufacturers will not employ spiffs.
- Even in contracting structures that do not exhibit easy customization, spiffs will not be observed with a monopolist seller of a product with stable demand.
- With contracting inflexibility, a monopolist seller of multiple products (or of products with seasonally shifting demand) is likely to try to use spiffs on the harder-to-sell product.
- With contracting inflexibility, a rep firm selling competing manufacturers’ goods will support spiffs on products that have both high base sales and high sales effort productivity.
- With contracting inflexibility and competing manufacturers selling through the rep firm, spiffs will be offered by the manufacturer of the strongest (i.e., easiest-to-sell) product as a means of fending off the competition (for rep salesperson selling time) from weaker products.

In the remainder of this section, we comment on the limitations of our model and possible extensions. In our model, players engage in a transaction game in which the manufacturers have all the power to make a take-it-or-leave-it offer.<sup>15</sup> Given this, the rep firm has no power to deter the use of spiffs by the manufacturers. Whereas we do not specifically evaluate

<sup>15</sup> Take it or leave it is a normalization commonly used in transaction games. The normalization involves giving the offer of power to one of the players and the acceptance or rejection of power (of the entire offer) to the other player. No bargaining or partial acceptance is allowed. See Shugan (2005) for a discussion of transaction games in marketing and how different players may have dissimilar preferences over transaction rules.

a model in which the rep firm has this veto power over spiffs, our results suggest that if there are contractual restrictions in the channel, a rep firm would do better by vetoing spiffs in single-supplier environments and also in competitive-supplier environments when high-productivity selling products do not have relatively large base sales. We refer the readers to the work of Iyer and Villas-Boas (2003) and Raju and Zhang (2005) for studies that provide some directions on how our results could change if the rep firm had more power (that could be translated to some veto power over spiffs).

The analysis presented here assumes that products sold by the rep firm are unrelated in demand, although the salesperson's time allocation decision between the two products naturally creates a relationship between them. However, it is common for rep firms to carry products that are complementary in demand in order to offer a "full line." In addition, the salesforce may perceive that disutility for high effort (simultaneously) on two products is greater than the sum of the disutilities of high effort on each product, thus creating a substitution interaction. In general, adding complementarity improves (substitution: decreases) system profitability because the salesperson's effort on one product casts a positive (negative) externality on sales of the other product, and this means a lower (higher) compensation burden for the system. Other than this, the results presented here for the independent-products case generally hold in the complementary-products case.<sup>16</sup>

Our analysis considers only one manufacturer with a pair of products or a pair of manufacturers with one product. However, our results hold in a general multiproduct situation when commissions are product specific at both the manufacturing and rep firm levels. The solution simply prescribes individual commission rates for each product, and the same channel system outcome can be obtained without the use of spiffs.

In the case of constraints on the rep firm contract with its salesforce in a monopoly manufacturing environment, the solution is for the monopolist to offer spiffs on all but the product with highest productivity of selling effort to bring the salesforce perception of the rewards to all products' selling efforts to the same level. Given this, a single commission from the rep firm is sufficient to induce the salesforce to exert high effort on all products.

In the case of constraints on the rep firm contract with its salesforce in a competitive environment, the

problem is much more complicated. The optimal solution requires that the manufacturer of the second-lowest productivity product implement a spiff level that just deters spiff competition from the least productive manufacturer. Similarly, the third-lowest productive manufacturer implements a spiff level that just deters the second-lowest productive manufacturer. Here, the difference is not designed to completely deter spiffs from the manufacturer of the second-lowest productivity product (after all, it is implementing some spiffs to deter the least productive manufacturer), but to deter the second lowest from attempting to engage in spiff competition with the third lowest, and so on.

In a sense, every manufacturer will try to "free ride" a little on less productive manufacturers. Ultimately, this could lead to one of two extreme situations. First, the least productive manufacturers might sequentially find it unprofitable to sell through the rep firm and drop from the system. Second, the (remaining) least productive manufacturer might not provide enough to support the participation constraint of the rep firm, and so the other manufacturers may increase their spiffs or set a manufacturer's commission different from zero just to help meet the participation constraint.

Last, we comment on our assumption that the channel intermediary does not purchase and hold inventory and, therefore, does not set final retail prices for the products it sells. This assumption, of course, accurately describes the rep firm channel. Nevertheless, a comparable analysis of the distributor channel (where distributors are intermediaries that do take title to manufacturers' products and hence do wield downstream pricing power) might further enhance our understanding of the interaction among contract structure, salesforce productivity, and the optimal allocation of marketing incentives in different intermediary channel structures.

Spiffs therefore serve an important channel-coordinating role in many real-world selling situations. They are, moreover, legal. Recent attacks (e.g., by Eliot Spitzer, the former attorney general of New York) on the insurance industry's practices of offering promotional payments to insurance brokers might appear to be attacks on the general use of spiffs but, in fact, hinge more on fraud and illegal bid rigging than on the legality of spiffs per se (*The Economist* 2004, Elkind 2004). Manufacturers and rep firms considering the use of spiffs, and those using them currently, therefore do not need to step back from using them as a channel-coordinating mechanism.

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<sup>16</sup> For a full analysis of these effects, see the aforementioned "Complementarity and Substitution Analysis" document, available from the *Marketing Science* website at <http://mktsci.pubs.informs.org>.

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## Appendix

**NOTATION.** In this appendix, *PC* and *IC* denote the standard participation constraint and incentive compatibility constraint in agency problems, while *LC* denotes a local incentive constraint (meaning that the agent in question should prefer to implement high effort in both tasks rather than implement high effort in only one of the tasks), and *GC* denotes a global incentive constraint (meaning that the agent in question should prefer to implement high effort in both tasks rather than implement low effort in both tasks). When preceded by an *S*, the constraints (*PC*, *IC*, *LC*, and *GC*) refer to the salesperson, while when preceded by an *R*, they refer to the rep firm.

**PROOF OF CLAIM 1.** To obtain the maximum outcome the channel system can get, we consider that the manufacturer and the rep firm vertically integrate and denote these two agents simply as the “firm.” The firm needs to offer the right contract to the salesperson so that she would prefer to implement high effort instead of any other outcome. In this case, the firm’s problem is

$$(P_{\text{sys}}^{m,\text{max}}): \max_{A \in \mathbb{R}, \mathbf{b}, \mathbf{z} \in \mathbb{R}_+} \sum_{i=1}^2 (1 - b_i - z_i) X_i [e_i] - A$$

subject to

$$\text{SPC: } \sum_{i=1}^2 \left[ (b_i + z_i) X_i [e_i] - \frac{r\sigma^2}{2} (b_i + z_i)^2 - C[e_i] \right] + A \geq m$$

$$\text{SIC: } \mathbf{e} \in \arg \max_{e_i \in \{L, H\}} \sum_{i=1}^2 \left[ (b_i + z_i) X_i [e_i] - \frac{r\sigma^2}{2} (b_i + z_i)^2 - C[e_i] \right] + A.$$

Because the terms  $b_i$  and  $z_i$  always appear together, spiffs are clearly unnecessary when the firm contracts directly with the salesforce; hence, we set  $\mathbf{z} = \{0, 0\}$ .

The salesperson has four effort options: exerting low selling effort for both products (*LL*), exerting high selling effort only for the first product (*HL*), exerting high selling effort only for the second product (*LH*), or exerting high effort for both products (*HH*). Her utility for each of these options is, respectively,

$$(U_{LL}^S): (b_1)(q_1) - \frac{r\sigma^2}{2} (b_1)^2 + (b_2)(q_2) - \frac{r\sigma^2}{2} (b_2)^2 + A,$$

$$(U_{HL}^S): (b_1)(q_1 + \Delta_1) - \frac{r\sigma^2}{2} (b_1)^2 + (b_2)(q_2) - \frac{r\sigma^2}{2} (b_2)^2 - c + A,$$

$$(U_{LH}^S): (b_1)(q_1) - \frac{r\sigma^2}{2} (b_1)^2 + (b_2)(q_2 + \Delta_2) - \frac{r\sigma^2}{2} (b_2)^2 - c + A,$$

$$(U_{HH}^S): (b_1)(q_1 + \Delta_1) - \frac{r\sigma^2}{2} (b_1)^2 + (b_2)(q_2 + \Delta_2) - \frac{r\sigma^2}{2} (b_2)^2 - 2c + A.$$

The salesperson’s optimal effort choice is driven by the firm’s choice of commissions  $\mathbf{b}$ . Because effort generates

disutility for the salesperson, the firm induces high effort in both tasks (*HH*) by solving the problem

$$(P_{\text{sys}}^{m,\text{max}}): \max_{A \in \mathbb{R}, \mathbf{b} \in \mathbb{R}_+} (1 - b_1)(q_1 + \Delta_1) + (1 - b_2)(q_2 + \Delta_2) - A$$

subject to

$$(\text{SPC}_{HH}): U_{HH}^S \geq m, \quad (\text{SGC}_{HHLL}): U_{HH}^S \geq U_{LL}^S,$$

$$(\text{SLC}_{HHLH}): U_{HH}^S \geq U_{LH}^S, \quad (\text{SLC}_{HHLH}): U_{HH}^S \geq U_{HL}^S.$$

Because tasks are independent, *SGC* is redundant. The solution to the above problem is

$$\mathbf{b}_{\text{sys}}^{m,\text{max}} = \left\{ \frac{c}{\Delta_1}, \frac{c}{\Delta_2} \right\},$$

$$A_{\text{sys}}^{m,\text{max}} = m + 2c - \left( \frac{c}{\Delta_1} \right) (q_1 + \Delta_1) - \left( \frac{c}{\Delta_2} \right) (q_2 + \Delta_2) + \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right).$$

By plugging these expressions into the firm’s profit function (adapted from Equation 3), we obtain

$$\pi_{\text{sys}}^{m,\text{max}} = (q_1 + \Delta_1 + q_2 + \Delta_2) - \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right) - m - 2c.$$

**PROOF OF PROPOSITION 1.** The manufacturer’s goal is to implement high selling effort for both products. Following the same notation as in the proof of Claim 1, the salesperson’s utilities for the four effort options  $\{(LL), (HL), (LH), (HH)\}$  are, respectively,

$$(U_{LL}^S): (b_1 + z_1)(q_1) - \frac{r\sigma^2}{2} (b_1 + z_1)^2 + (b_2 + z_2)(q_2) - \frac{r\sigma^2}{2} (b_2 + z_2)^2 + A,$$

$$(U_{HL}^S): (b_1 + z_1)(q_1 + \Delta_1) - \frac{r\sigma^2}{2} (b_1 + z_1)^2 + (b_2 + z_2)(q_2) - \frac{r\sigma^2}{2} (b_2 + z_2)^2 - c + A,$$

$$(U_{LH}^S): (b_1 + z_1)(q_1) - \frac{r\sigma^2}{2} (b_1 + z_1)^2 + (b_2 + z_2)(q_2 + \Delta_2) - \frac{r\sigma^2}{2} (b_2 + z_2)^2 - c + A,$$

$$(U_{HH}^S): (b_1 + z_1)(q_1 + \Delta_1) - \frac{r\sigma^2}{2} (b_1 + z_1)^2 + (b_2 + z_2)(q_2 + \Delta_2) - \frac{r\sigma^2}{2} (b_2 + z_2)^2 - 2c + A.$$

The salesperson’s optimal effort choice is driven by the rep firm’s choice of the commissions  $\mathbf{b}$  and the manufacturer’s choice of spiffs incentives  $\mathbf{z}$ . If the rep firm wants to implement low effort for both products (*LL*), then the  $\text{SIC}_{LL}$  constraint is slack and the rep firm’s problem is

$$(P_{R,LL}^{m,\text{free}}): \max_{A \in \mathbb{R}, b_i \in \mathbb{B}_i} (y_1 - b_1)q_1 + (y_2 - b_2)q_2 - A$$

subject to

$$(\text{SPC}_{LL}): U_{LL}^S \geq m.$$

The solution to this problem is simply to give minimal commission to the salesperson and a salary that is just high enough to guarantee her minimum utility:

$$\mathbf{b}_{LL}^* = \{-z_1, -z_2\}, \quad A_{LL}^* = m. \quad (\text{A1})$$

If the rep firm wants to implement high effort in only one of the tasks, i.e., (*HL*) or (*LH*), then the rep firm faces a standard principal-agent problem:

$$(P_{R\_HL}^{m\_free}): \max_{A \in \mathbb{R}, b_i \in \mathbb{B}_i} (y_1 - b_1)(q_1 + \Delta_1) + (y_2 - b_2)q_2 - A$$

subject to

$$(\text{SPC}_{HL}): U_{HL}^S \geq m, \quad (\text{SIC}_{HL}): U_{HL}^S \geq U_{LL}^S.$$

$$(P_{R\_LH}^{m\_free}): \max_{A \in \mathbb{R}, b_i \in \mathbb{B}_i} (y_1 - b_1)q_1 + (y_2 - b_2)(q_2 + \Delta_2) - A$$

subject to

$$(\text{SPC}_{LH}): U_{LH}^S \geq m, \quad (\text{SIC}_{LH}): U_{LH}^S \geq U_{LL}^S.$$

The solutions to the above problems are, respectively,

$$\mathbf{b}_{HL}^* = \left\{ \frac{c}{\Delta_1} - z_1, -z_2 \right\}, \quad (\text{A2})$$

$$A_{HL}^* = m + c - \left( \frac{c}{\Delta_1} \right) (q_1 + \Delta_1) + \frac{r\sigma^2}{2} \left( \frac{c}{\Delta_1} \right)^2,$$

$$\mathbf{b}_{LH}^* = \left\{ -z_1, \frac{c}{\Delta_2} - z_2 \right\}, \quad (\text{A3})$$

$$A_{LH}^* = m + c - \left( \frac{c}{\Delta_2} \right) (q_2 + \Delta_2) + \frac{r\sigma^2}{2} \left( \frac{c}{\Delta_2} \right)^2.$$

Last, if the rep firm wants high effort in both tasks (*HH*), then it faces the problem:

$$(P_{R\_HH}^{m\_free}): \max_{A \in \mathbb{R}, b_i \in \mathbb{B}_i} (y_1 - b_1)(q_1 + \Delta_1) + (y_2 - b_2)(q_2 + \Delta_2) - A$$

subject to

$$(\text{SPC}_{HH}): U_{HH}^S \geq m, \quad (\text{SGC}_{HHLL}): U_{HH}^S \geq U_{LL}^S,$$

$$(\text{SLC}_{HHLL}): U_{HH}^S \geq U_{LH}^S, \quad (\text{SLC}_{HHHL}): U_{HH}^S \geq U_{HL}^S.$$

Since tasks are independent, *SGC* is redundant. The solution to the above problem is

$$\mathbf{b}_{HH}^* = \left\{ \frac{c}{\Delta_1} - z_1, \frac{c}{\Delta_2} - z_2 \right\},$$

$$A_{HH}^* = m + 2c - \left( \frac{c}{\Delta_1} \right) (q_1 + \Delta_1) - \left( \frac{c}{\Delta_2} \right) (q_2 + \Delta_2) + \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right). \quad (\text{A4})$$

Now we are ready to analyze the manufacturer's problem. If the manufacturer wants to implement high effort in both tasks (*HH*), it has to make sure the rep firm will provide incentives for the salesperson, so she works hard on both tasks.

By plugging the results from expressions (A1) to (A4) into the rep firm's profit function (adapted from Equation 2),

we obtain the rep firm's profits for each of the possible outcomes:

$$(\pi_{R\_LL}): (y_1 + z_1)(q_1) + (y_2 + z_2)(q_2) - m,$$

$$(\pi_{R\_HL}): (y_1 + z_1)(q_1 + \Delta_1) + (y_2 + z_2)(q_2) - m - c - \frac{r\sigma^2}{2} \left( \frac{c}{\Delta_1} \right)^2,$$

$$(\pi_{R\_LH}): (y_1 + z_1)(q_1) + (y_2 + z_2)(q_2 + \Delta_2)$$

$$- m - c - \frac{r\sigma^2}{2} \left( \frac{c}{\Delta_2} \right)^2,$$

$$(\pi_{R\_HH}): (y_1 + z_1)(q_1 + \Delta_1) + (y_2 + z_2)(q_2 + \Delta_2)$$

$$- m - 2c - \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right).$$

Hence, to implement (*HH*), the manufacturer will face the problem

$$(P_{M\_HH}^{m\_free}): \max_{y, z \in \mathbb{R}_+} (1 - y_1 - z_1)(q_1 + \Delta_1) + (1 - y_2 - z_2)(q_2 + \Delta_2)$$

subject to

$$(\text{RPC}_{HH}): \pi_{R\_HH} \geq 0, \quad (\text{RGC}_{HHLL}): \pi_{R\_HH} \geq \pi_{R\_LL},$$

$$(\text{RLC}_{HHLL}): \pi_{R\_HH} \geq \pi_{R\_LH}, \quad (\text{RLC}_{HHHL}): \pi_{R\_HH} \geq \pi_{R\_HL}.$$

Because the terms  $y_i$  and  $z_i$  always appear together, spiffs are unnecessary; hence, we set  $\mathbf{z} = \{0, 0\}$ . Because selling effort is independent across products, *RGC* is redundant. The solution to this problem is obtained by solving the *RLC* constraints with equality, which yields the solution

$$\mathbf{y}_{HH}^* = \left\{ \frac{c(c(r\sigma^2/2) + \Delta_1^2)}{\Delta_1^3}, \frac{c(c(r\sigma^2/2) + \Delta_2^2)}{\Delta_2^3} \right\}, \quad \mathbf{z}_{HH}^* = \{0, 0\}.$$

One can verify that this solution satisfies the *RPC*, unless the minimum utility  $m$  for the salesperson is very high. If  $m$  was indeed very high, then we would have a corner solution and we would need to solve the problem for the *RPC*. Since we are interested in interior solutions, we will assume that this is not the case here.

Therefore, the optimal contractual provisions that implement high effort in both tasks are:  $\mathbf{b}^{m\_free} = \mathbf{b}_{HH}^*$ ,  $A^{m\_free} = A_{HH}^*$ ,  $\mathbf{y}^{m\_free} = \mathbf{y}_{HH}^*$ , and  $\mathbf{z}^{m\_free} = \mathbf{z}_{HH}^*$ .

Finally, plugging these solutions into the rep firm's and into the manufacturer's profit functions (adapted from Equations 2 and 3), we obtain the expressions:

$$\pi_R^{m\_free} = \frac{c(c(r\sigma^2/2) + \Delta_1^2)}{\Delta_1^3} (q_1 + \Delta_1) + \frac{c(c(r\sigma^2/2) + \Delta_2^2)}{\Delta_2^3} (q_2 + \Delta_2) - \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right) - 2c - m,$$

$$\pi_M^{m\_free} = \left[ 1 - \frac{c(c(r\sigma^2/2) + \Delta_1^2)}{\Delta_1^3} \right] (q_1 + \Delta_1) + \left[ 1 - \frac{c(c(r\sigma^2/2) + \Delta_2^2)}{\Delta_2^3} \right] (q_2 + \Delta_2).$$

**PROOF OF PROPOSITION 2.** The manufacturer's goal is to implement high selling effort for both products. As in the



proof of Claim 1, the salesperson's utilities for the four effort options are

$$(U_{LL}^S): (b+z_1)(q_1) - \frac{r\sigma^2}{2}(b+z_1)^2 + (b+z_2)(q_2) - \frac{r\sigma^2}{2}(b+z_2)^2 + A,$$

$$(U_{HL}^S): (b+z_1)(q_1 + \Delta_1) - \frac{r\sigma^2}{2}(b+z_1)^2 + (b+z_2)(q_2) - \frac{r\sigma^2}{2}(b+z_2)^2 - c + A,$$

$$(U_{LH}^S): (b+z_1)(q_1) - \frac{r\sigma^2}{2}(b+z_1)^2 + (b+z_2)(q_2 + \Delta_2) - \frac{r\sigma^2}{2}(b+z_2)^2 - c + A,$$

$$(U_{HH}^S): (b+z_1)(q_1 + \Delta_1) - \frac{r\sigma^2}{2}(b+z_1)^2 + (b+z_2)(q_2 + \Delta_2) - \frac{r\sigma^2}{2}(b+z_2)^2 - 2c + A.$$

The salesperson's optimal effort choice is driven by the rep firm's choice of the commission  $b$  and the manufacturer choice of spiffs incentives  $\mathbf{z}$ . If the rep firm wants to implement low effort for both products ( $LL$ ), then the SIC constraint is slack and the rep firm's problem is

$$(P_{R_{LL}}^{m\_spiff}): \max_{A \in \mathbb{R}, b \in \mathbb{B}} (y-b)q_1 + (y-b)q_2 - A$$

subject to

$$(SPC_{LL}): U_{LL}^S \geq m.$$

The solution to this problem is simply to give minimal commission to the salesperson and a salary that is just high enough to guarantee the minimum utility for the salesperson:

$$\begin{aligned} b_{LL}^* &= \max\{-z_1, -z_2\}, \\ A_{LL}^* &= m - (z_1 + b_{LL}^*)q_1 - (z_2 + b_{LL}^*)q_2 \\ &\quad + \frac{r\sigma^2}{2}[(z_1 + b_{LL}^*)^2 + (z_2 + b_{LL}^*)^2]. \end{aligned} \quad (A5)$$

If the rep firm wants to implement high effort in only one of the tasks, i.e., ( $HL$ ) or ( $LH$ ), then the rep firm faces a standard principal-agent problem:

$$(P_{R_{HL}}^{m\_spiff}): \max_{A \in \mathbb{R}, b \in \mathbb{B}} (y-b)(q_1 + \Delta_1) + (y-b)q_2 - A$$

subject to

$$(SPC_{HL}): U_{HL}^S \geq m, \quad (SIC_{HL}): U_{HL}^S \geq U_{LL}^S.$$

$$(P_{R_{LH}}^{m\_spiff}): \max_{A \in \mathbb{R}, b \in \mathbb{B}} (y_1 - b)q_1 + (y_2 - b)(q_2 + \Delta_2) - A$$

subject to

$$(SPC_{LH}): U_{LH}^S \geq m, \quad (SIC_{LH}): U_{LH}^S \geq U_{LL}^S.$$

The solutions to the above problems are, respectively,

$$\begin{aligned} b_{HL}^* &= \frac{c}{\Delta_1} - z_1, \\ A_{HL}^* &= m + c - \left(\frac{c}{\Delta_1} - z_1\right)(q_1 + \Delta_1 + q_2) + r\sigma^2 \left(\frac{c}{\Delta_1} - z_1\right)^2, \end{aligned} \quad (A6)$$

$$b_{LH}^* = \frac{c}{\Delta_2} - z_2, \quad (A7)$$

$$A_{LH}^* = m + c - \left(\frac{c}{\Delta_2} - z_2\right)(q_1 + q_2 + \Delta_2) + r\sigma^2 \left(\frac{c}{\Delta_2} - z_2\right)^2.$$

However, because we have only one control for the commission rate, it is impossible to induce high effort only on the lower-productivity product unless  $\mathbf{z}$  is such that  $b_{HL}^* = b_{LH}^*$ . In our case in which  $\Delta_1 > \Delta_2$ , the rep firm cannot implement ( $LH$ ) because the commission  $b$  that makes  $U_{LH}^S > U_{LL}^S$  automatically makes  $U_{HL}^S > U_{LL}^S$ . Hence, the rep firm by its own means can only implement ( $LL$ ), ( $HL$ ), or ( $HH$ ). This also means that the highest salesforce commission rate from Equations (A6) and (A7) already implements high effort in both tasks.

If the manufacturer wants to implement ( $HH$ ), it has to make sure the rep firm will provide the incentives for the salesperson to work hard on both tasks. This requires a salesperson commission of  $b_{HH} = \max\{(c/\Delta_1) - z_1, (c/\Delta_2) - z_2\}$ .

To completely understand the equilibrium of this problem, consider first the outcome if the manufacturer cannot use spiffs ( $\mathbf{z} \equiv \{0, 0\}$ ). Because  $c/\Delta_2 = \max\{(c/\Delta_1) - 0, (c/\Delta_2) - 0\}$ , the compensation to the salesperson would be

$$b_{HH}^{no} = \frac{c}{\Delta_2}, \quad (A8)$$

$$A_{HH}^{no} = m + 2c - \left(\frac{c}{\Delta_2}\right)(q_1 + \Delta_1 + q_2 + \Delta_2) + r\sigma^2 \left(\frac{c}{\Delta_2}\right)^2.$$

In this case, by plugging the results from expressions (A5) to (A8) into the rep firm's profit function (adapted from Equation 2), we obtain the rep firm's profits for each of the possible outcomes:

$$(\pi_{R_{LL}}): (y)(q_1) + (y)(q_2) - m,$$

$$(\pi_{R_{HL}}): (y)(q_1 + \Delta_1) + (y)(q_2) - m - c - r\sigma^2 \left(\frac{c}{\Delta_1}\right)^2,$$

$$(\pi_{R_{LH}}): \text{"not possible,"}$$

$$(\pi_{R_{HH}}): (y)(q_1 + \Delta_1) + (y)(q_2 + \Delta_2) - m - 2c - r\sigma^2 \left(\frac{c}{\Delta_2}\right)^2.$$

Therefore, to implement ( $HH$ ) the manufacturer will face the problem

$$(P_{M_{HH}}^{no}): \max_{y, \mathbf{z} \in \mathbb{R}_+} (1-y)(q_1 + \Delta_1) + (1-y)(q_2 + \Delta_2)$$

subject to

$$(RPC_{HH}): \pi_{R_{HH}} \geq 0, \quad (RGC_{HHLL}): \pi_{R_{HH}} \geq \pi_{R_{LL}},$$

$$(RLC_{HHHL}): \pi_{R_{HH}} \geq \pi_{R_{HL}}.$$

Unless the selling-effort productivities of both products are very similar,  $RGC$  is slack and  $RLC$  is the only binding constraint. Hence, solving  $RLC$  with equality we obtain the solution to this problem:  $y_{HH}^{no} = c(1 + (c r \sigma^2 / \Delta_2^2) - (c r \sigma^2 / \Delta_1^2)) / \Delta_2$ .

Therefore, the optimal contractual provisions that implement high effort in both tasks when the manufacturer cannot spiff are  $b^{m\_no} = b_{HH}^{no}$ ,  $A^{m\_no} = A_{HH}^{no}$ ,  $y^{m\_no} = y_{HH}^{no}$ , and  $\mathbf{z}^{m\_no} = \mathbf{z}_{HH}^{no}$ . One can verify that these solutions satisfy the  $RPC$ , unless the minimum utility  $m$  for the salesperson is

very high. These provisions would yield optimal profits to the manufacturer and rep firm of

$$\begin{aligned}\pi_M^{m,no} &= \left[ 1 - \frac{c(1 + (c\sigma^2/\Delta_2^2) - (c\sigma^2/\Delta_1^2))}{\Delta_2} \right] (q_1 + \Delta_1 + q_2 + \Delta_2), \\ \pi_R^{m,no} &= \left[ \frac{c(1 + (c\sigma^2/\Delta_2^2) - (c\sigma^2/\Delta_1^2))}{\Delta_2} \right] (q_1 + \Delta_1 + q_2 + \Delta_2) \\ &\quad - r\sigma^2 \left( \frac{c^2}{\Delta_2^2} \right) - 2c - m.\end{aligned}$$

However, because *spiffs are indeed possible* ( $\mathbf{z} \in \mathbb{R}_+$ ), it is optimal for the manufacturer to provide spiffs on the lower selling-effort productivity product so as to equate the salesperson's reward for exerting effort in any of the two products. This entails  $z_1^{m,spiff} = 0$ , and  $z_2^{m,spiff} = (c/\Delta_2) - (c/\Delta_1)$ .

Given this, the rep firm contract that makes the salesperson prefer (*HH*) now entails

$$\begin{aligned}b_{HH} &= \frac{c}{\Delta_1}, \\ A_{HH} &= m + 2c - \left( \frac{c}{\Delta_1} \right) (q_1 + \Delta_1) - \left( \frac{c}{\Delta_2} \right) (q_2 + \Delta_2) \\ &\quad + \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right).\end{aligned}$$

Now, the rep firm cannot make the salesperson work hard in only one of the tasks, because for any commission  $b$  it sets, the combination of commission and spiff makes each product equally rewarding. Thus, either the salesperson does not work hard or she works hard in both tasks.

Hence, to implement (*HH*) the manufacturer will face the modified problem

$$(P_{M,HH}^{spiff}): \max_{y, \mathbf{z} \in \mathbb{R}_+} (1-y)(q_1 + \Delta_1) + \left( 1 - y - \frac{c}{\Delta_2} + \frac{c}{\Delta_1} \right) (q_2 + \Delta_2)$$

subject to

$$(RPC_{HH}): \pi_{R,HH} \geq 0, \quad (RGC_{HHLL}): \pi_{R,HH} \geq \pi_{R,LL},$$

in which only the global constraint *RGC* will bind.

Solving *RGC* with equality we obtain the commission rate  $y_{HH}^{spiff} = c(c\sigma^2 + \Delta_1\Delta_2 + \Delta_2^2)/(\Delta_1\Delta_2(\Delta_1 + \Delta_2))$ , which is the rate the manufacturer needs to provide the rep firm so that it will be indifferent between the outcomes of high effort in both tasks or low effort in both tasks.

Therefore, when spiffs are possible the rep firm optimal contract to the salesforce entails

$$\begin{aligned}b^{m,spiff} &= \frac{c}{\Delta_1}, \\ A^{m,spiff} &= m + 2c - \left( \frac{c}{\Delta_1} \right) (q_1 + \Delta_1) - \left( \frac{c}{\Delta_2} \right) (q_2 + \Delta_2) \quad (A9) \\ &\quad + \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right).\end{aligned}$$

The optimal manufacturer contract to the rep firm and salesforce entails

$$\begin{aligned}y^{m,spiff} &= \frac{c(c\sigma^2 + \Delta_1\Delta_2 + \Delta_2^2)}{\Delta_1\Delta_2(\Delta_1 + \Delta_2)}, \\ \mathbf{z}^{m,spiff} &= \left\{ 0, \frac{c}{\Delta_2} - \frac{c}{\Delta_1} \right\}.\end{aligned} \quad (A10)$$

Equilibrium profits for the manufacturer and rep firm are, respectively,

$$\begin{aligned}\pi_M^{m,spiff} &= \left[ 1 - \frac{c(c\sigma^2 + \Delta_1\Delta_2 + \Delta_2^2)}{\Delta_1\Delta_2(\Delta_1 + \Delta_2)} \right] (q_1 + \Delta_1 + q_2 + \Delta_2) \\ &\quad - \left( \frac{c}{\Delta_2} - \frac{c}{\Delta_1} \right) (q_2 + \Delta_2), \\ \pi_R^{m,spiff} &= \left[ \frac{c(c\sigma^2 + \Delta_1\Delta_2 + \Delta_2^2)}{\Delta_1\Delta_2(\Delta_1 + \Delta_2)} \right] (q_1 + \Delta_1 + q_2 + \Delta_2) \\ &\quad - \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_1^2} + \frac{c^2}{\Delta_2^2} \right) - \frac{c(q_2 + \Delta_2)}{\Delta_1} - c - m.\end{aligned}$$

Recall that  $\Delta_1 > \Delta_2$ , and thus one can verify that the manufacturer does better when spiffs are possible because

$$\begin{aligned}\pi_M^{m,spiff} - \pi_M^{m,no} &= \left[ \frac{r\sigma^2}{\Delta_2} \left( \frac{c^2}{\Delta_2^2} - \frac{c^2}{\Delta_1^2} \right) - \frac{c^2 r\sigma^2}{\Delta_1\Delta_2(\Delta_1 + \Delta_2)} \right] \\ &\quad \cdot (q_1 + \Delta_1 + q_2 + \Delta_2) + \left( \frac{c}{\Delta_2} - \frac{c}{\Delta_1} \right) (q_1 + \Delta_1)\end{aligned}$$

is positive. One can also verify that the rep firm does better when spiffs are not possible, because

$$\begin{aligned}\pi_R^{m,spiff} - \pi_R^{m,no} &= - \left[ \frac{r\sigma^2}{\Delta_2} \left( \frac{c^2}{\Delta_2^2} - \frac{c^2}{\Delta_1^2} \right) - \frac{c^2 r\sigma^2}{\Delta_1\Delta_2(\Delta_1 + \Delta_2)} \right] \\ &\quad \cdot (q_1 + \Delta_1 + q_2 + \Delta_2) - \left( \frac{c}{\Delta_2} - \frac{c}{\Delta_1} \right) (q_1 + \Delta_1) \\ &\quad + \frac{r\sigma^2}{2} \left( \frac{c^2}{\Delta_2^2} - \frac{c^2}{\Delta_1^2} \right)\end{aligned}$$

is negative.

**PROOF OF PROPOSITION 4.** Each manufacturer wants to implement high selling effort for its product. The optimal strategies for the salesforce and for the rep firm are mathematically identical to those in the proof of Proposition 2, so they are not repeated here.

Knowing the optimal behavior of the rep firm and its salesforce, the manufacturers simultaneously solve the problem

$$(P_{HH}^o, spiff): \max_{y_j, z_j \in \mathbb{R}_+} (1 - y_j - z_j)(q_j + \Delta_j) \quad \text{for } j \in \{1, 2\}$$

subject to

$$\begin{aligned}(RPC_{HH}): \pi_{R,HH} \geq 0, \quad (RGC_{HHLL}): \pi_{R,HH} \geq \pi_{R,LL}, \\ (RLC_{HHLL}): \pi_{R,HH} \geq \pi_{R,LH}, \quad (RLC_{HHHL}): \pi_{R,HH} \geq \pi_{R,HL},\end{aligned}$$

where the profits for the rep firm come from the proof of Proposition 2. The solution to this problem is more complicated than simply solving for the constraints.

Recall that manufacturer 1 has the product with higher selling-effort productivity. We label this manufacturer  $m_1$  and the other manufacturer  $m_2$ . If manufacturers could not offer spiffs,  $m_1$  would be inclined to adopt a very small commission ( $y_1 \rightarrow 0$ ) yet still could enjoy high effort, since it could free ride in the rigid rep firm's compensation contract. In this case,  $m_2$  would suffer the burden of paying a large commission that would support high effort on both  $m_1$ 's and  $m_2$ 's products.

Let us investigate the outcome if the manufacturer *cannot use spiffs* ( $\mathbf{z} \equiv \{0, 0\}$ ). In this situation, the equilibrium commission to the salesperson would be

$$b_{HH}^{no} = \frac{c}{\Delta_2},$$

$$A_{HH}^{no} = m + 2c - \left(\frac{c}{\Delta_2}\right)(q_1 + \Delta_1 + q_2 + \Delta_2) + r\sigma^2\left(\frac{c}{\Delta_2}\right)^2,$$

because  $c/\Delta_2 = \max\{(c/\Delta_1) - 0, (c/\Delta_2) - 0\}$ .

In this case, by plugging  $y_1 = 0$ ,  $\mathbf{z} = \{0, 0\}$ , and the results from the rep firm's solutions in the proof of Proposition 2 (expressions A5 to A8) into the rep firm's profit function (adapted from Equation 2), we obtain the rep firm's profits for each of the possible outcomes:

$$(\pi_{R\_LL}): (y_2)(q_2) - m,$$

$$(\pi_{R\_HL}): (y_2)(q_2) - m - c - r\sigma^2\left(\frac{c}{\Delta_1}\right)^2,$$

$$(\pi_{R\_LH}): \text{“not possible,”}$$

$$(\pi_{R\_HH}): (y_2)(q_2 + \Delta_2) - m - 2c - r\sigma^2\left(\frac{c}{\Delta_2}\right)^2.$$

Hence, if m2 wants high effort exerted on its product, this automatically implies high effort on product 1 as well. Firm m2 therefore solves the problem

$$(P_{M2\_HH}^{no}): \max_{y_2 \in \mathbb{R}_+} (1 - y_2)(q_2 + \Delta_2)$$

subject to

$$(RPC_{HH}): \pi_{R\_HH} \geq 0, \quad (RGC_{HHLL}): \pi_{R\_HH} \geq \pi_{R\_LL},$$

$$(RLC_{HHHL}): \pi_{R\_HH} \geq \pi_{R\_HL}.$$

It is easy to see here that *RLC* is slack and *RGC* is the only binding constraint. Hence, solving *RGC* with equality we conclude that m2's optimal commission payment to the rep firm is  $y_{HH}^{o,no} = (c^2 r \sigma^2 + 2c \Delta_2^2) / \Delta_2^3$ . This leads to optimal manufacturer profits, rep firm profits, and total channel profits of

$$\pi_{M1}^{o,no} = q_1 + \Delta_1,$$

$$\pi_{M2}^{o,no} = \left[1 - \frac{c^2 r \sigma^2 + 2c \Delta_2^2}{\Delta_2^3}\right](q_2 + \Delta_2),$$

$$\pi_R^{o,no} = \frac{c^2 r \sigma^2 + 2c \Delta_2^2}{\Delta_2^3}(q_2 + \Delta_2) - r\sigma^2\left(\frac{c}{\Delta_2}\right)^2 - 2c - m,$$

$$\pi_{\text{sys}}^{o,no} = (q_1 + \Delta_1 + q_2 + \Delta_2) - r\sigma^2\left(\frac{c}{\Delta_2}\right)^2 - 2c - m.$$

However, because *spiffs are indeed possible* ( $\mathbf{z} \in \mathbb{R}_+$ ), m2 can try to provide enough spiffs to the salesperson so that exerting high selling effort on product 2 would become more profitable than exerting high selling effort on product 1, and thus assume the privileged position of being the free-ride manufacturer. Firm m1 would consequently react by also offering spiffs.

To find the equilibrium, we need to define the indifference point such that m2 does not find it profitable to engage in this spiffing war. This condition is for m1 to provide enough spiffs such that m2 would be indifferent between also providing spiffs and not providing any spiffs.

When m2 does not provide spiffs, the maximum profit it can earn is obtained by solving the local constraint  $RGC_{HHLL}$  with equality for  $y_2$ , obtaining

$$y_2^{\text{accommodate}} = \frac{c(cr\sigma^2 + r\sigma^2 z_1 \Delta_2 + 2\Delta_2^2) - z_1 \Delta_1 \Delta_2^2}{\Delta_2^3}.$$

Hence, when m2 does not use spiffs, its profit as a function of spiffs  $z_1$  is given by

$$\pi_2^{\text{accommodate}} = \left[1 - \frac{c(cr\sigma^2 + r\sigma^2 z_1 \Delta_2 + 2\Delta_2^2) - z_1 \Delta_1 \Delta_2^2}{\Delta_2^3}\right](q_2 + \Delta_2). \quad (A11)$$

On the other hand, to surpass m1 in productivity of selling effort, m2 has to offer a large enough amount of spiff so that  $z_2 > ((z_1 \Delta_1 / \Delta_2) + b(\Delta_1 - \Delta_2 / \Delta_2))$ . In this case, the rep firm would pay the salesperson a commission of  $b = ((c/\Delta_1) - z_1)$ , which would be enough to provide incentives to implement high selling effort on m1's product (because high selling effort on m2's would occur naturally).

Therefore, the maximum profit outcome m2 could obtain through a “surpassing” strategy occurs when  $y_2 = 0$  and  $z_2 = z_1 + c(1/\Delta_2 - 1/\Delta_1)$ . Its profits are then given by

$$\pi_2^{\text{surpass}} = \left[1 - z_1 - c\left(\frac{1}{\Delta_2} - \frac{1}{\Delta_1}\right)\right](q_2 + \Delta_2). \quad (A12)$$

The indifference point occurs when expressions (A11) and (A12) are equated. Because these expressions are independent of  $y_1$ , we conclude that it is optimal to set  $y_1 = 0$  and adjust the expressions only with  $z_1$ . Solving  $\pi_2^{\text{accommodate}} = \pi_2^{\text{surpass}}$  for  $z_1$ , we obtain

$$z_1^{o\_spiffs} = \frac{c[\Delta_2^2(\Delta_1 + \Delta_2) + cr\sigma^2 \Delta_1]}{\Delta_1 \Delta_2 [\Delta_2(\Delta_1 + \Delta_2) - cr\sigma^2]}.$$

By plugging this result into m2's manufacturer commission  $y_2^{\text{accommodate}}$ , we obtain

$$y_2^{o\_spiffs} = \frac{c[\Delta_1(\Delta_1 + \Delta_2) + cr\sigma^2]}{\Delta_1 [\Delta_2(\Delta_1 + \Delta_2) - cr\sigma^2]}.$$

Once again, one can verify that this solution satisfies the *RPC*, unless the minimum utility  $m$  for the salesperson is very high.

When both manufacturers want to assure high selling effort on their respective products, the unique possible equilibrium<sup>17</sup> is

$$y_1^{o\_spiff} = 0, \quad y_2^{o\_spiff} = \frac{c[\Delta_1(\Delta_1 + \Delta_2) + cr\sigma^2]}{\Delta_1 [\Delta_2(\Delta_1 + \Delta_2) - cr\sigma^2]},$$

$$z_1^{o\_spiff} = \frac{c[\Delta_2^2(\Delta_1 + \Delta_2) + cr\sigma^2 \Delta_1]}{\Delta_1 \Delta_2 [\Delta_2(\Delta_1 + \Delta_2) - cr\sigma^2]}, \quad z_2^{o\_spiff} = 0.$$

Substituting for the solution variables into the manufacturers' profit functions (adapted from Equation 3), we obtain the manufacturers' optimal profits:

$$\pi_{M1}^{o\_spiff} = [1 - z_1^{o\_spiffs}](q_1 + \Delta_1),$$

$$\pi_{M2}^{o\_spiff} = [1 - y_2^{o\_spiffs}](q_2 + \Delta_2).$$

<sup>17</sup> In fact, manufacturer 1 should offer an infinitesimal amount more than  $z_1^{o\_spiff}$  to secure a unique equilibrium. Also, notice that if manufacturers do not require high effort in their tasks, a mixed strategies equilibrium can be reached.

The rep firm's equilibrium profits can then be expressed as an implicit function of the optimal manufacturer contractual provisions:

$$\pi_R^{o\_spiff} = (q_1 + \Delta_1)z_1^{o\_spiff} + (q_2 + \Delta_2)y_2^{o\_spiff} - \frac{r\sigma^2}{2} \left[ \left( \frac{c}{\Delta_2} + z_1^{o\_spiff} \right)^2 + \frac{c^2}{\Delta_2^2} \right] - 2c - m.$$

Clearly, m1 does better if spiffs are not possible because

$$\pi_{M1}^{o\_spiff} - \pi_{M1}^{o\_no} = (0 - z_1^{o\_spiffs})(q_1 + \Delta_1) < 0.$$

However, m2 does better when spiffs are possible because

$$\pi_{M2}^{o\_spiff} - \pi_{M2}^{o\_no} = (-y_2^{o\_spiffs} + y_2^{o\_no})(q_2 + \Delta_2) > 0.$$

To see this, notice that

$$y_2^{o\_spiffs} - y_2^{o\_no} = \frac{(c\sigma^2 - \Delta_1\Delta_2)[\Delta_2^2(\Delta_1 + \Delta_2) + c\sigma^2\Delta_1]}{\Delta_1\Delta_2^3[\Delta_2(\Delta_1 + \Delta_2) - c\sigma^2]}$$

is negative, unless  $c\sigma^2$  is much greater than both  $\Delta_1$  and  $\Delta_2$ , which is impossible because the marginal productivity of selling effort is higher than the marginal cost of effort.

Finally, the difference in profits for the rep firm between the two spiffs regimes is

$$\pi_R^{o\_spiff} - \pi_R^{o\_no} = (z_1^{o\_spiffs} - 0)(q_1 + \Delta_1) + (y_2^{o\_spiffs} - y_2^{o\_no}) \cdot (q_2 + \Delta_2) - \frac{r\sigma^2}{2} \left[ \left( \frac{c}{\Delta_2} + z_1^{o\_spiff} \right)^2 - \frac{c^2}{\Delta_2^2} \right].$$

This implies that in general, when  $q_1$  is significantly larger than  $q_2$ , then  $\pi_R^{o\_spiff} - \pi_R^{o\_no} > 0$ . Conversely, when  $q_2$  is significantly larger than  $q_1$ , then  $\pi_R^{o\_spiff} - \pi_R^{o\_no} < 0$ .

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