

## **Designing Sales Contests: Does the Prize Structure Matter?**

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## **Designing Sales Contests: Does the Prize Structure Matter?**

### **ABSTRACT**

Sales contests are short-term incentives that are widely used by managers to raise effort levels of salespeople to meet firms' objectives. The extant marketing theory predicts that the prize structure of a sales contest is an important determinant of sales effort and the optimal prize structure should have two characteristics: 1) the number of prizewinners should be greater than one; and that 2) prize values should be unique and rank-ordered. However, this theory has not been empirically examined.

This paper presents two empirical studies that test if varying the prize structure of a sales contest leads to differences in sales performance. In each study, we investigate the incremental effects of introducing multiple prizewinners and unique rank-ordered prizes into a sales contest. The first study consists of a pair of laboratory experiments in which participants make decisions that closely reflect the decision trade-offs in the theoretical model of sales contests. The second study consists of two field economic experiments where trained salespeople sell fundraising sponsorships to companies. The results across the experiments are remarkably consistent: The number of prizewinners in a sales contest should indeed be greater than one. However, introducing rank-ordered prizes into contests with multiple prizewinners does not produce any boost to sales effort and revenues.

Keywords: Sales Contests, Sales Management, Experimental Economics, Field Experiments.

## 1. INTRODUCTION

Sales contests are short-term incentives used by managers to motivate salespeople to meet sales targets. It is estimated that up to 90% of firms with a sales force regularly conduct sales contests (Murphy and Sohi 1995) and total expenditures on sales contests in the United States were reported to be over \$26 billion in 2000 (*Federation Study* 2001). When designing a sales contest, one of the major questions managers confront is: What should be the prize structure of the contest? Specifically, how many prizewinners should there be and what should be the value of each prize?

A survey of industry practices reveals that firms have used a variety of prize structures in their sales contests. To name a few, Avis Rent-A-Car conducted a contest with the simplest possible prize structure – a One-Winner contest where the salesperson with the highest dollar sales wins a dinner for two (*Sales and Marketing Management* 1995). Phillips Foods used a Grouped-Winners format, that is, a contest with multiple prizewinners and identical prize values. In this instance, the top four salespeople each won an all-expense-paid trip to Baltimore (*Frozen Food Age* 2006). Webb Furniture implemented a Ranked-Winners contest that has multiple prizewinners and unique rank-ordered prizes – the top-ranked seller won \$10,000, and sellers ranked 2<sup>nd</sup> to 5<sup>th</sup> won \$8000, \$6000, \$4000, and \$2000 respectively (*Furniture Today* 2005). NBC adopted a prize structure that is a hybrid of the Grouped-Winners and Ranked-Winners contests – there were three “gold prizes” where the top three cable advertisement sellers won a trip to New York or Los Angeles, ten “silver prizes” where the next ten highest-ranked sellers won a trip to a conference, followed by hundreds of “bronze prizes” where sellers received t-shirts and coffee mugs (*Multichannel News* 2004). Given the range of prize structures that have

been adopted by firms in practice and the plethora of alternative contest designs, managers have to decide on the following questions: Does the prize structure of a sales contest matter at all? Is there an optimal prize structure and what are its characteristics?

In a significant contribution to marketing theory, Kalra and Shi (2001) addressed the above questions and showed that the prize structure in a sales contest is an important determinant of sales effort.<sup>1</sup> Using a game-theoretic model, they demonstrated that under the regular assumptions of risk-averse salespeople and logistically-distributed sales outcomes, the optimal prize structure is the Ranked-Winners contest, which has the following two characteristics: 1) the number of prizewinners is greater than one; and 2) prizes are rank-ordered and unique to that rank, that is, salespeople ranked higher should receive prizes with greater monetary values and that salespeople with different sales ranks should not receive prizes with identical values. The intuition for their result is as follows: First, since risk-averse salespeople place less incremental value on larger prize spreads, it is better to allocate the total prize money across more ranks. Second, having unique rank-ordered prizes motivates salespeople to increase effort to achieve the highest sales ranks possible, since every rank that is higher (above the lowest rank that qualifies them as a prizewinner) carries more monetary reward. The upshot is that when managers conduct sales contests, they should increase the design complexity of a prize structure by introducing both multiple prizewinners and unique rank-ordered prizes in order to reap the greatest boost in sales effort and revenues.

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<sup>1</sup> There are a few other papers in marketing that study sales contests, but only Kalra and Shi (2001) address the question of the optimal prize structure from the perspective of a profit-maximizing firm. For example, Murphy, Dacin and Ford (2004) survey salespeople about their preferences for monetary awards, the duration of a contest, and the proportion of winners in a contest. On the last issue, they show that the most-preferred contest is one where prizes are awarded to the top 40% of contestants. Gaba and Kalra (1999) study the degree of risk-taking behavior by varying the proportion of “winners” (i.e., subjects who receive a prize) in a contest. They show that more risky prospects were chosen when the proportion of winners is “low”. They study only the Grouped-Winners contest in their paper.

However, the usefulness of the theory has been limited because its predictions have not been empirically examined. The need for empirical validation is especially strong given that the theoretical predictions, which are based on comparing the symmetric multi-person Nash equilibrium effort levels across different prize structures, rely on two assumptions that may not be met even in the best-controlled empirical settings. First, salespeople are assumed to be completely homogeneous in their preferences and sales effectiveness. Second, they are assumed to be motivated only by monetary incentives and can make perfectly accurate strategic trade-offs between the costs of expending sales effort and the expected rewards given by a prize structure in a sales contest. We note that it is virtually impossible (and probably not useful) to replicate the perfect homogeneity assumption, particularly in salespeople's preferences over monetary outcomes, in any empirical test. Moreover, for the theory to be useful, it must accommodate bounded-rational behavior, such as different levels of strategic sophistication among salespeople (Ho, Lim and Camerer 2006, Ho, Camerer and Chong 2004). Given that both heterogeneity and bounded rationality are unavoidable when theory is translated into an empirical setting, the predictions of the marketing theory of sales contests are by no means assured, even if the primary goal of the empirical test is to examine if those predictions can be supported by the aggregate behavior across the contestants.

Furthermore, the criteria for a valid empirical test cannot be met by data that are typically available to marketing researchers. First, to construct a causal test of whether the prize structure of a sales contest affects sales effort and revenues, both exogenous variation in the prize structures and the random assignment of salespeople into different contest formats are required. Second, since sales effort is a strategic variable in a sales contest and can vary with the number of contestants, it is crucial to ensure that the number of salespeople in each contest is identical.

Third, an accurate test of theory must include the theoretically optimal (or effort-maximizing) prize distribution for the Ranked-Winners contest, as there are many ways to distribute prize values across ranks under this prize structure. To ensure this, the researcher would need to have *ex ante* control over the parameters that influence the effort-maximizing design, such as the aggregate degree of risk aversion of the salespeople and the effects of other monetary incentives that are available to salespeople.<sup>2</sup> The only empirical methodology that meets these criteria is an economic experiment, that is, an experimental study where decisions are aligned with monetary incentives (see Amaldoss et al. 2000, Amaldoss and Jain 2002, 2005, Ding et al. 2005, Lim and Ho 2007, Krishna and Ünver 2007 for successful applications in marketing).

This paper presents a combination of laboratory and field economic experiments that addresses the empirical question of whether the prize structure in a sales contest matters. We examine the performance of three different prize structures by adopting the following experimental design: First, we investigate the incremental impact of introducing multiple winners into a contest by comparing the simplest One-Winner contest with the Grouped-Winners and Ranked-Winners contests. Second, we study the impact of introducing unique rank-ordered prizes in contests with multiple prizewinners by comparing the Grouped-Winners contest with the theoretically optimal Ranked-Winners contest. In the laboratory experiments, participants make decisions that closely reflect the trade-offs salespeople face when choosing sales effort. The results from the laboratory experiments represent the most accurate empirical outcomes of the theoretical model since the researcher wields the greatest degree of control over the factors

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<sup>2</sup> As previously mentioned, the theoretically optimal sales contest has multiple winners and unique rank-ordered prizes. To determine the actual optimal number of winners and each of the prize values in a contest, the manager would need to know the salespeople's degree of risk aversion and ensure that the participation constraint of each salesperson (which could be affected by other compensation schemes, such as fixed salaries and incentives for specific products) is satisfied. The paper will elaborate on these parameters in the later sections.

that affect whether the model's assumptions are satisfied. The field economic experiments consist of a pair of studies – the first compares the One-Winner contest to the Grouped-Winners contest in a setting where salespeople sell fundraising sponsorships through a golf tournament, while the second compares the Grouped-Winners and Ranked-Winners contests in an environment where salespeople raise funds for a university educational program. The main purpose of the field experiments is to provide researchers with insights on the usefulness of the theoretical model in those environments where the theory is expected to apply. This paper is also one of the very first in marketing to employ the methodology of field economic experiments.<sup>3</sup>

The results of the laboratory and field experiments are remarkably consistent: The prize structure of a sales contest does matter, but not exactly in the way the prevailing wisdom predicts. Our findings strongly indicate that introducing multiple prizewinners into a sales contest does indeed improve sales performance. However, introducing unique rank-ordered prizes into a multiple-winner sales contest does not boost sales effort and revenues. In other words, the Grouped-Winners contest performs as well as the Ranked-Winners contest. Hence, designing the optimal sales contest is less complex than what existing theory prescribes, because managers need not solve for the prize values for each prizewinner – they simply need to fix the prize values to be identical across winners and focus on determining the optimal number of winners.<sup>4</sup>

The remainder of the paper is organized as follows. The next section describes the economic model underlying the marketing theory of sales contests and presents the hypotheses to

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<sup>3</sup> The distinguishing feature of a field economic experiment is that it is based on the experimental economics methodology. See Harrison and List (2004) for an introduction to this methodology. See Krishna and Ünver (2007) for another example of field economic experiments - they examine the efficiency of course-bidding mechanisms in business schools.

<sup>4</sup> As will be evident in Section 2, this is a much less complex problem because the optimal number of winners in the Grouped-Winners contest can be determined by using a simple formula.

be tested. Next, we detail the design and results of the laboratory experiments. This is followed by the design and the results of the field experiments. The final section concludes with the managerial implications and a discussion of the limitations of the current paper, as well as future research directions.

## 2. MODEL AND THEORETICAL PREDICTIONS

### 2.1 Model Overview

In a sales contest, there are  $N$  salespeople contending for prizes based on their individual sales ranking, which is determined by a sales metric (usually dollar sales). The prize structure of a sales contest is given by  $P_1 \geq P_2 \geq \dots \geq P_N$ , where  $P_1$  is the monetary value received by the salesperson with the highest rank, and so on. Let  $P_j \geq 0$  denote the monetary value received by the salesperson with the  $j^{\text{th}}$  rank ( $j = 1, 2, 3, \dots, N$ ). The manager is given a budget,  $B$ , for the total prize money in the sales contest and has to decide on a prize structure that will motivate salespeople to expend the greatest sales effort. In this paper, we define the terms “prizewinner”, “winner” and “prize” to refer only to those cases where  $P_j > 0$ .

The marketing theory of sales contests was first proposed by Kalra and Shi (2001) and draws on tournament theory in economics (Lazear and Rosen 1982, Green and Stokey 1983, Nalebuff and Stiglitz 1983) and the marketing literature on sales compensation (e.g. Basu et al. 1985). The optimal prize structure for a sales contest is derived via the following steps: (1) The firm must determine how salespeople make decisions about sales effort given a prize structure; (2) the manager incorporates knowledge about salespeople’s behavior into his decision calculus and chooses the prize structure that maximizes the firm’s profits. In this paper, we will highlight

only the features of the model that are critical for understanding the experimental tests in the following sections, and refer the reader to the first section of the Web Appendix for other important mathematical details of the salesperson's behavior and the manager's decisions in the model.

The theory of sales contests assumes that all the  $N$  salespeople in the contest are homogeneous in their preferences and sales abilities. Given a prize structure, each salesperson,  $i$ , chooses an effort level,  $e_i$ , which maximizes his utility. The salesperson's utility is assumed to be separable in monetary rewards and sales effort, and is given by  $U(R_i, e_i) = u(R_i) - c(e_i)$ . The salesperson is assumed to be risk averse over the monetary outcomes ( $u'(R_i) > 0$  and  $u''(R_i) < 0$ ). The most common specification for  $u(R_i)$  is the Constant Relative Risk Aversion (CRRA) utility function  $R_i^\alpha / \alpha$ , where  $0 < \alpha < 1$ . The parameter,  $\alpha$ , captures the salesperson's degree of risk aversion, with a lower  $\alpha$  indicating greater aversion to risk. Sales effort is costly (i.e., time for other activities needs to be sacrificed), and the cost of effort  $c(e_i)$  is assumed to be strictly increasing and convex. The sales metric by which the salesperson is ranked is  $s(e_i) = h(e_i) + \varepsilon_i$ , where  $h(e_i)$  is the deterministic sales-effort function that represents the salesperson's ability to convert effort into dollar sales, while  $\varepsilon_i$  is a stochastic component that reflects uncertainty in sales faced by each salesperson (e.g., changes in customer demand). The assumptions of the model are that  $h'(e_i) > 0$ ,  $h''(e_i) < 0$  and  $\varepsilon_i \sim \text{Logistic}(0, \pi^2 \beta^2 / 3)$ .

Each salesperson evaluates the tradeoff between expending sales effort and the probability of attaining monetary rewards for a given prize structure by choosing effort to maximize his expected utility. Given the above setup and applying the common specifications of

$h(e_i) = e_i$  and  $c(e_i) = ke_i^2$ , Kalra and Shi (2001) showed that the closed-form equilibrium effort level of each salesperson for a given prize structure is:<sup>5</sup>

$$(1) \quad e^* = \sum_{j=1}^N \frac{P_j^\alpha (N - 2j + 1)}{2k\alpha\beta N(N + 1)}.$$

The manager rationally anticipates the salesperson's behavior and takes this into account when choosing the prize structure that maximizes the firm's profits. To design the optimal contest, the manager also has to ensure that the resultant expected utility of each salesperson is above a reservation level (i.e., satisfying the salesperson's participation constraint) and that the total value of the prizes must be equal to  $B$ .

## *2.2 Theory Prediction: The Prize Structure of a Sales Contest Matters*

Kalra and Shi (2001) showed that the optimal prize structure is a Ranked-Winners (RW) contest that has multiple winners (that is,  $P_{w^*} > 0$ , where  $w^* > 1$ ) and unique rank-ordered prizes. They also examined two other prize structures described earlier in this paper, the One-Winner (1W) contest and the Grouped-Winners (GW) contest, and explained why they do not yield as much sales effort as the Ranked-Winners contest.<sup>6</sup>

First, the optimal sales contest must have more than one prizewinner. This is because when salespeople are risk averse, their marginal valuations for larger prize values are lower compared to their marginal valuations for smaller prizes. This leads to smaller optimal prize spreads, which means that it is better to have prizes with smaller values across ranks than to have

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<sup>5</sup> These specifications are also used in Bull, Schotter and Weigelt (1987) and does not affect the optimal prize structure.

<sup>6</sup> There are many ways to distribute prizes within the Ranked-Winners and Grouped-Winners prize structures. In this paper, we consider only the optimal, or effort-maximizing, design for each prize structure.

a single large prize. This principle from the marketing theory of sales contests can be formally described as the following hypothesis:

**H1:** *When salespeople are risk averse, sales contests with multiple prizewinners are superior to a sales contest with only one prizewinner. Specifically, the pattern of sales effort in the following prize structures is predicted to be:*

$$\mathbf{H1a.} \quad e^*(RW) > e^*(1W)$$

$$\mathbf{H1b.} \quad e^*(GW) > e^*(1W)$$

We note that the optimal number of prizewinners in a sales contest increases with the salesperson's level of risk aversion. In the Grouped-Winners prize structure, it can be shown that the optimal number of prizewinners,  $w_{GW}^*$ , is equal to  $\text{Max}\{1, [N(1-\alpha)/(2-\alpha)]\}$ , where  $[N(1-\alpha)/(2-\alpha)]$  is rounded off to the nearest integer.

Second, the marketing theory of sales contests states that prize values should be unique and rank-ordered because having prize spreads motivate salespeople to obtain the highest ranks possible. If all prize values across the "winning ranks" (the first  $w^*$  ranks where prizes are awarded) are identical, then the salesperson has no incentive to expend effort to achieve ranks that are higher than the lowest rank that qualifies for a prize. The same logic applies to any pair of consecutive winning ranks, and hence no two prize values should be identical. Naturally, larger prizes should be awarded for higher ranks so that salespeople will expend effort to achieve the highest possible sales rankings. Formally, the prediction is:

**H2:** *In sales contests with multiple prizewinners, sales effort is higher in the prize structure with unique rank-ordered prize values, relative to the one where prize values are identical. That is,  $e^*(RW) > e^*(GW)$ .*

Before proceeding to describe the experimental tests of the hypotheses above, our paper extends the existing theory by providing insights to the following question: Given that the optimal prize structure of a sales contest must have the two characteristics of multiple winners

and unique rank-ordered prizes, what is the relative importance of these two characteristics? Put differently, what are the effort losses if managers implement the simpler One-Winner or Grouped-Winners designs, instead of the optimal Ranked-Winners prize structure?

[Insert Table 1 Here]

Table 1 provides the outcome of our analysis for parameter values of  $B=\$100$ ,  $\beta=1$  and  $k=10$ .<sup>7</sup> Columns 1 and 2 shows the respective effort-maximizing contest designs for the Ranked-Winners and the Grouped-Winners prize structures for different contest sizes ( $N=8, 15$ ) and levels of risk aversion ( $\alpha=0.25, 0.5, 0.75$ ). Columns 3 and 4 show the relative sales effort in the One-Winner and Grouped-Winners contests respectively, as a percentage of the sales effort in the optimal Ranked-Winners contest. First, column 3 indicates that the greatest boost to sales effort from adopting the more complex Ranked-Winners prize structure over the simplest One-Winner design occurs when salespeople are more risk averse. Second, sales effort under the Grouped-Winners prize structure ranges from 94.5 to 96% of that of the Ranked-Winners contest. That is, the incentive effect of achieving higher ranks, conditional on being a prizewinner, is small. These observations imply that the benefit of having multiple prizewinners (while keeping prize values identical) is greater than the marginal effect of introducing unique rank-ordered prizes into contests with multiple prizewinners.

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<sup>7</sup> The parameter values of  $B=100$ ,  $\beta=1$  and  $k=10$  are chosen both for simplicity and to ensure that the participation constraint of the salesperson is satisfied in all three prize structures given the levels of  $N$  and  $\alpha$ . We do not vary  $\beta$  and  $k$  because the effort-maximizing designs of the Ranked-Winners and Grouped-Winners prize structures do not depend on these parameters as long as the salesperson's participation constraint is met. Our analyses using other parameter values yield similar results. We did not find any cases where the relative effort of Grouped-Winners is lower than 93%.

### 3. LABORATORY EXPERIMENTS

We conduct a pair of laboratory experiments that are designed to test the two hypotheses above. In order for the experiments to be considered valid empirical tests of the marketing model of sales contests, several other criteria have to be considered. Table 2 outlines these criteria and how well they are met by the laboratory experiments in this paper.

[Insert Table 2 Here]

First, as aforementioned, the prize distributions in the Grouped-Winners and Ranked-Winners contests must be the theoretically optimal ones. To obtain these, the researcher must first specify the level of the contest size  $N$  and the total prize money  $B$ , estimate the degree of risk aversion,  $\alpha$ , of the salespeople, and ensure that the participation constraint is satisfied. Moreover, both the contest size and the total prize money must be identical across different contests. Second, although not a necessary condition for a valid test, it is useful if the precise level of effort (or a decision proxy) can be predicted and directly observed. This can only be accurately done in the laboratory setting when the sales-effort function, cost of effort function, and the variance parameter of the logistically-distributed sales outcomes ( $h(e)$ ,  $c(e)$  and  $\beta$  respectively) can be explicitly specified by the researcher. Third, the model assumes that the salespeople are homogeneous in sales productivity and their degree of risk aversion. In the laboratory experiments, we are able to meet the homogeneity assumption for sales productivity as  $h(e)$ ,  $c(e)$  and  $\beta$  are identical and common knowledge to all salespeople. However, we do not control for homogeneity of risk aversion for two reasons: First, we are unaware of any reliable method of inducing an identical level of risk aversion across contestants. Second and more importantly, since managers do not have control over salespeople's risk preferences (and do not

attempt to homogenize levels of risk aversion when designing sales contests), we believe that it is important for the theory to be empirically validated under this condition.<sup>8</sup> In this case, the procedure that is closest to satisfying the assumption is to estimate an aggregate level of risk aversion across the contestants, and to use this measure to design the theoretically optimal sales contest. Finally, we recognize that there may be concerns about external validity issues as the laboratory experiments do not involve trained salespeople undertaking real selling tasks. This concern is addressed with the field experiments.

The structure of the laboratory experiments in this paper is similar to earlier papers that test tournament theory in economics and management (Bull, Schotter and Weigelt 1987, Schotter and Weigelt 1992, Orrison, Schotter and Weigelt 2004), except for two major innovations introduced in this paper. First, our paper studies complex prize structures such as the Ranked-Winners contests with as many as eight contestants, whereas the focus of earlier papers was on simpler prize structures with a smaller group of contestants. Second, the prize distributions in the Ranked-Winners and Grouped-Winners contests were endogenously determined after the aggregate risk aversion parameter was estimated, so that they correspond to the theoretically optimal prize distributions for each prize structure.<sup>9</sup>

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<sup>8</sup> In contrast, managers often try to meet the homogeneity assumptions for sales productivity in order to create a contest that is perceived by contestants to be fair, through adjusting the sales metric by which salespeople are ranked. For example, instead of gross sales, the metric might be sales dollars over quota and/or sales for a new line of products.

<sup>9</sup> The earlier papers either study the One-Winner prize structure with two contestants (Bull, Schotter and Weigelt 1987, Schotter and Weigelt 1992) or compare the One-Winner and Grouped-Winner prize structures while letting the number of contestants (two, four or six) and the total prize money  $B$  vary. The prize distributions in the Grouped-Winner contests were also exogenously determined and the contestants were assumed to be risk neutral. Moreover, sales outcomes were assumed to be uniformly distributed.

### 3.1 Experiment 1

The first laboratory experiment compares the One-Winner, Grouped-Winners and the Ranked-Winners contests using a between-subjects design. Before the prize values in the contests with multiple prizewinners can be specified, we have to estimate the aggregate level of risk aversion of the salespeople.

*Measuring Risk Aversion.* The procedure used was introduced by Holt and Laury (2002). 120 subjects were randomly recruited from students in an undergraduate sales management class who had indicated their availability to participate in our experiments. Each student was given a questionnaire containing six lottery-choice questions, and their task was to select one of two lotteries (called Option A and Option B) for each of the six questions. The six questions for one of the two payoff conditions we employed are shown in Columns 1 and 2 of Table 3. Note that across the six decisions, the stakes in Options A (safer choice) and B (riskier choice) are fixed while the probabilities vary, with the differences in the expected value of the two options (which were not provided to the subjects) increasing in favor of Option B as subjects move down the questions. The basic idea of this procedure is that the level of risk aversion of each subject can be inferred from the number of safe choices (Option A) she makes before crossing over to Option B, because the choice proportion corresponds to an interval for the risk aversion parameter,  $\alpha$ , in the CRRA utility function. For example, if a subject chooses Option A for the first two decisions followed by Option B for the next four, it implies  $0.59 < \alpha < 0.85$  for that subject. 60 subjects were given the exact lotteries in Table 3, while the other 60 made choices in another payoff condition where the stakes in Table 3 were increased by 1.5 times. The lottery stakes were chosen so that they span the range of monetary outcomes from participating in the experimental contests. Before the subjects made their decisions, they were told that six of them would be randomly

selected (we ultimately selected three from each payoff condition) to participate in one of the six questions, and they would play the lottery (Option A or B) which they had selected for that question. All payments were made in cash, and all six subjects received their payments within a week of the study.

[Insert Table 3 Here]

Using the choice data, we estimated an aggregate risk aversion parameter for the subjects using a probabilistic choice rule first derived by Luce (1959), where a decision-maker's probability of choosing Option A, when faced with two options A and B with respective utilities  $U_A$  and  $U_B$ , is given by  $\Pr(A) = U_A^{1/\lambda} / [U_A^{1/\lambda} + U_B^{1/\lambda}]$ , where  $\lambda$  is a rationality parameter that captures the degree of sensitivity of choice probabilities to utilities (with smaller values representing greater sensitivity). This choice rule also has the property that choice probabilities remain unchanged when payoffs are scaled by a multiplicative constant, so that subjects who select the same number of safe choices across the two payoff conditions have the same degree of risk aversion. The Maximum-Likelihood estimate of the aggregate risk aversion parameter across the two payoff conditions is  $\alpha=0.476$  (Log Likelihood = -376.22 and  $\lambda=0.132$ ), which is not significantly different from  $\alpha=0.5$  ( $\chi^2=0.628$ , d.f.=1,  $p=0.427$ ).<sup>10</sup>

*Design Parameters.* The values of the other parameters we selected are  $B=\$15$ ,  $N=8$ ,  $h(e)=e$ ,  $c(e)=ke^2$ ,  $k=0.0002$  and  $\beta=30$ . Together with the risk aversion coefficient estimate of  $\alpha=0.5$ , these parameter values yield the effort-maximizing designs of  $\{\$5.00, \$5.00, \$5.00, \$0.00, \dots, \$0.00\}$  and  $\{\$8.75, \$4.46, \$1.61, \$0.18, \$0.00, \dots, \$0.00\}$  for the Grouped-Winners and Ranked-

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<sup>10</sup> See Goeree, Holt and Palfrey (2005) for a detailed derivation and application of this choice rule. Holt and Laury (2002) reported the risk aversion coefficient estimates from the experiments they conducted and those of several other papers in economics. The range is from 0.33 to 0.71.

Winners contests respectively. The theoretical predictions of sales effort are 62.76, 77.64 and 82.17 for the One-Winner, Grouped-Winners and Ranked-Winners prize structures respectively. The contest designs and predictions are also shown in the top half of Table 4. The parameter values were selected so they meet all of the following conditions: First, we chose  $B=\$15$  (for each contest in each decision round) so that the monetary incentives will be sufficiently motivating. Second, we wanted  $N$  to be large enough so that the optimal number of prizewinners in each of the Grouped-Winners and Ranked-Winners contests is greater than two, hence we selected  $N=8$ . Third, we used the simple functions of  $h(e)=e$  and  $c(e)=0.0002e^2$  to reduce the mathematical complexity of the decision tasks. Fourth, since we knew that the predicted effort levels for the Grouped-Winners and Ranked-Winners can be very close, we chose parameters that separate the point predictions as much as possible. Fifth, we did not want the predictions to be anchored on any focal numbers. Finally, the parameter combination above was chosen so that the participation constraints for the subjects are satisfied in all of the contests.

[Insert Table 4 Here]

*Procedure.* A total of 72 subjects were randomly selected from the 120 participants who completed the risk-aversion survey to participate in the experiment. These subjects were further randomly divided into three sessions of 24 subjects each, with each session assigned to one of three prize structures studied (One-Winner, Grouped-Winners and Ranked-Winners contests). Subjects received course credit for arriving on time and were paid in cash privately at the end of the experiment. Subjects earned an average of US\$19, with the minimum and maximum at \$2 and \$57 respectively. Each experimental session consisted of 15 decision rounds and lasted about an hour. Since there were 24 subjects in a session and  $N=8$ , there were three contest groups in every round. In each round, subjects were randomly and anonymously matched with seven other

contestants. Also, subjects were reminded that each of them would encounter the same set of contestants only once during the 15 rounds. This was done to minimize any reputation effects, so that the one-shot nature of the theoretical model is preserved. Once subjects entered the laboratory, they were seated at separate computer terminals and the instructions were read aloud by the experimenter. The experiment was implemented using *Z-Tree* software (Fischbacher 1999).

The instructions and the decision task were designed to be as simple as possible. Following earlier experimental tests of tournament theory (Bull, Schotter and Weigelt 1987, Schotter and Weigelt 1992, Orrison, Schotter and Weigelt 2004), the instructions did not contain the words ‘contest,’ ‘prize,’ ‘winning’ and ‘losing’ so that no non-pecuniary incentives were introduced. Subjects were told that their decision task is to select a *Decision Number* ( $e_i$ ) from 30 to 100. Each *Decision Number* is associated with a *Decision Cost* ( $0.0002e_i^2$ ), which is greater the higher the *Decision Number* they choose. The *Decision Cost* corresponding to each *Decision Number* was provided to each subject using an information sheet.<sup>11</sup> Subjects were then told that once they enter their *Decision Number* into the computer program, the program would generate a *Random Number* ( $\varepsilon_i$ ) that ranges from -172 to 172.<sup>12</sup> To explain the probability distribution of  $\varepsilon_i$ , we did not use the term “logistic distribution”, but rather communicated the concept to the subjects in three complementary ways using another information sheet: We provided 1) a histogram showing the relative frequencies of the numbers, 2) a table showing the probabilities

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<sup>11</sup> The full set of instructions and the information sheets are available from the authors upon request.

<sup>12</sup> As the logistic distribution is continuous with an infinite range, we had to “discretize” and truncate the distribution in order to simplify the instructions. To do so, we first calculated the probability that each integer  $x$  will be drawn using  $F(X < x + 0.5) - F(X < x - 0.5)$ . Next, we selected the endpoints with a view to balance the tradeoff between overloading the subjects with too much information and achieving an accurate representation of a logistic density with  $\beta=30$ . With endpoints of -172 and 172, we found that using the expected frequencies for each integer for 5000 draws produces a Maximum-Likelihood estimate of  $\beta=29.37$  (Log Likelihood=-26730). This is not significantly different from  $\beta=30$  ( $\chi^2=3.0$ , d.f.=1,  $p=0.083$ ).

for every interval of ten numbers (e.g., -169 to -160, -159 to -150) except for the endpoints, where the interval size was three (i.e., -172 to -170 and 170 to 172), and 3) a “full table” that displays the probability that each integer will be drawn. Subjects were next told that the computer will add the *Decision Number* with the *Random Number* to form the *Final Number* ( $s(e_i)$ ), by which they will be ranked from highest (Rank 1) to lowest (Rank 8). They will then earn a *Fixed Payment* ( $P_j$ ) that corresponds to their rank. The *Fixed Payment* for each rank varies with the contest treatment that subjects are in. The cash earning for each subject in each round was equal to the *Fixed Payment* minus the *Decision Cost*. We also gave every subject a start-up payment of \$5 in all the three treatment sessions. This was done so that the cash earnings of the subjects would remain positive especially in the earlier rounds. After completing a practice round to familiarize themselves with the software, subjects proceeded to choose their *Decision Number* for fifteen rounds.

*Results.* Figure 1 reports the actual average effort level (*Decision Number*) for the three prize structures. Across the fifteen rounds, average effort is 58.06, 74.21 and 75.40 in the One-Winner, Grouped-Winners and Ranked-Winners contests respectively. The key observation in the graph is that average effort in the One-Winner contest is directionally lower than the contests with multiple prizewinners in every round. Moreover, the average effort level in the Ranked-Winners contest is not always directionally higher relative to the Grouped-Winners contest.

[Insert Figure 1 Here]

We now proceed to conduct formal statistical tests of the hypotheses. Since subjects make multiple decisions in the experiments, we account for potential within-subject correlation by clustering the standard errors at the subject level in all the statistical tests we report. We begin

by comparing the average effort across all rounds with the theoretical point predictions in each of the contests using one-sample  $t$ -tests. In the One-Winner and Ranked-Winners contests, average effort is lower than the respective predicted levels of 62.76 ( $t=-2.00$ ,  $p=0.046$ ) and 82.17 ( $t=-2.93$ ,  $p=0.004$ ). The underinvestment in effort is small, as the hypothesis that average effort is equal to 96% of the predicted effort levels cannot be rejected for the One-Winner ( $t=-0.93$ ,  $p=0.35$ ) and Ranked-Winners ( $t=-1.51$ ,  $p=0.13$ ) contests. In the Grouped-Winners contest, average effort of 74.21 is not significantly different from the theoretical prediction of 77.64 ( $t=-1.58$ ,  $p=0.116$ ). Next, we check if there are dynamics in the data in each of the three contests by grouping the data into five blocks of three rounds and performing Ordinary Least Squares (OLS) regressions of effort on the blocks (with one of the blocks as the base). For the One-Winner contest, the only difference in effort across blocks arises between Block 1 (rounds 1-3) and Block 3 (rounds 7-9), with effort higher in the latter ( $p=0.012$ ). There are no differences in effort across the blocks of rounds in the Grouped-Winners contest. In the Ranked-Winners contest, the only differences across blocks is that effort in Block 5 (rounds 13-15) is significantly higher than effort in Blocks 1 and 4 ( $p$ -values 0.01 and 0.011 respectively). However, effort in Block 5 is no different than effort in Blocks 2 and 3. Overall, while there are no consistent directional trends in the data, there are some differences in effort across blocks. Consequently, we report the results of the hypotheses tests for the data pooled across all rounds and also on a block-by-block basis.

*Result 1: Sales Contests with Multiple Prizewinners Lead to Higher Effort*

The top half of Table 5 displays the results of OLS regressions of effort on prize structures for the pooled data and for each of the five blocks. In each of the regressions, the One-Winner contest was chosen as the base, with treatment dummies for the prize structures with

multiple prizewinners. The results of the regression for the pooled data in the first column confirm the predictions of Hypothesis 1 – relative to the One-Winner contest, effort is higher in the Grouped-Winners contest ( $t=5.04$ ,  $p=0.000$ ) and in the Ranked-Winners contest ( $t=5.26$ ,  $p=0.000$ ). The other columns in Table 5 show that this result holds when the data is analyzed on a block-by-block basis.

[Insert Table 5 Here]

*Result 2: Having Unique Rank-Ordered Prizes Does Not Lead to Higher Effort.*

We now test Hypothesis 2, which states that effort will be higher in the Ranked-Winners contest compared to the Grouped-Winners contest because the prize spreads of unique rank-ordered prizes in the former motivate salespeople to aim for the highest possible sales rankings. The bottom half of Table 5 displays the results of the OLS regressions of effort on prize structures with the Grouped-Winners contest as the base treatment. There is no difference in effort between the Grouped-Winners and the Ranked-Winners contests for the pooled data ( $t=0.37$ ,  $p=0.71$ ). This finding also holds when the data is analyzed at the block level – in each of the five blocks, there is no statistical difference in effort between the two contests at the 5% level.

*Discussion.* The results of the OLS regressions with standard errors clustered at the subject-level support the prediction that contests with multiple prizewinners lead to higher effort, but not the prediction that having unique rank-ordered prizes boosts effort further. We also conduct two additional statistical tests that confirm these findings. First, we perform an ANOVA with the prize structure as a between-subjects factor and the decision round as a within-subjects factor. The results show that the prize structure of a sales contest does affect effort ( $F_{2,69}=17.57$ ,

$p=0.000$ ), and the tests of effort between contests show that effort in the both the Ranked-Winners and Grouped-Winners contests are higher than that of the One-Winner contest (both  $p$ -values= $0.000$ ), while there is no difference in effort between the Ranked-Winners and Grouped-Winners contests ( $p=0.718$ ). Next, we used the average effort of each subject as the unit of analysis. The nonparametric Mann-Whitney tests reveal that relative to the One-Winner contest, effort is higher in the Ranked-Winners ( $Z=4.27$ ,  $p=0.000$ ) and the Grouped-Winners ( $Z=4.43$ ,  $p=0.000$ ) contests. Again, effort levels are not different across the two multiple prizewinners contests ( $Z=0.536$ ,  $p=0.592$ ).

We were also able to estimate the implied risk aversion coefficient of the subjects using the experimental data and the expression for equilibrium effort in equation 1. The Nonlinear Least Squares estimate of the aggregate risk aversion coefficient is 0.505 ( $t=11.60$ ,  $p=0.000$ ) while the Maximum-Likelihood estimate (assuming that effort decisions are normally-distributed with the equilibrium effort as the mean) is 0.507. These estimates provide additional evidence that our measure of 0.476 using Holt and Laury's (2002) procedure tracks the aggregate risk aversion of the subjects well.

Finally, we computed the power of the tests in the OLS regressions, assuming a Type I error rate of 5% and using the theoretical predictions of the differences across the contests as the alternative hypothesis. In the power calculations, we also account for the fact that each subject makes repeated observations (so that effort decisions by the same subject are not independent); consequently, the power levels we report are more conservative. For the tests of Hypotheses 1a and 1b, the power of each of the tests is above 0.99. However, the power of the test of

Hypothesis 2 is 0.30, which is below the usual benchmark of 0.8.<sup>13</sup> This is mainly due to the fact that the predicted effort levels in the Grouped-Winners and Ranked-Winners contests are small. Because the power of the test is too low, we designed a second laboratory experiment that can test Hypothesis 2 with sufficient statistical power.

### 3.2 Experiment 2

In this experiment, we employ a within-subject design (which yields more statistical power compared to a between-subjects design) to study if having unique rank-ordered prizes in sales contests with multiple prizewinners boosts effort. The contests we study are the Grouped-Winners and Ranked-Winners contests. There were 48 subjects divided evenly between 2 experimental sessions, each consisting 30 decision rounds. In one session, subjects made effort decisions in the Grouped-Winners contest for 15 rounds, followed by the Ranked-Winners contest for another 15 rounds. In the other session, the treatment order was reversed. The experimental procedure is identical to Experiment 1 except for the following: Because the subjects participate in two different contests, subjects were told at the start of the experiment that the *Fixed Payment* schedule will change after round 15 (they were also shown the *Fixed Payment* schedules of both contests). These *Fixed Payment* schedules correspond to the prize structure of the contests. Next, instead of earning cash directly, subjects earned points for the 30 rounds they participated, which were converted into dollars at a rate 0.45 dollars per point earned, so that the dollar value of the total prize money,  $B$ , in each round was 0.45 times 15 points, which is equal to \$6.75.

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<sup>13</sup>Accounting for within-subject correlations while performing the power calculations is important, as we would have obtained an erroneous power level of 0.84 had we not done so.

To design the optimal prize distributions for Grouped-Winners and Ranked-Winners contests, we use Holt and Laury's (2002) procedure (explained earlier) to estimate the aggregate risk aversion coefficient for the subjects. 70 potential participants (including all the 48 subjects who actually participated) answered the lottery choice questions given in Table 3, and the estimated risk aversion coefficient,  $\alpha$ , is 0.55 (Log-Likelihood=-225.3,  $\lambda=0.155$ ). Given this estimate and using the parameters values of  $B=15$ ,  $N=8$ ,  $h(e)=e$ ,  $c(e)=0.0002e^2$  and  $\beta=30$  we used in Experiment 1, we obtain the effort-maximizing designs (in points) of  $\{5.00, 5.00, 5.00, 0.00, \dots, 0.00\}$  and  $\{9.16, 4.33, 1.39, 0.12, 0.00, \dots, 0.00\}$  for the Grouped-Winners and Ranked-Winners contests respectively, with corresponding effort predictions of 81.59 and 76.50 (see bottom half of Table 4).

[Insert Figure 2 Here]

*Results.* As done in Experiment 1, we account for within-subject correlation by clustering the standard errors at the subject level in all the statistical tests we report. Figure 2 shows the average effort levels across all the fifteen rounds for the two prize structures. In the Grouped-Winners contest, average effort is 76.34, which is not significantly different from the predicted level of 76.50 ( $t=-0.07$ ,  $p=0.944$ ). Average effort is 76.31 in the Ranked-Winners contest, which is lower than the predicted 81.59 ( $t=-2.29$ ,  $p=0.022$ ). Again, the level of underinvestment in effort is small, as the hypothesis that average effort is equal to 97% of the predicted effort level cannot be rejected ( $t=-1.23$ ,  $p=0.22$ ). Furthermore, when we divide the data in five blocks of three rounds each, OLS regressions of effort on blocks reveal no statistical differences in effort among blocks in each of the contests.

[Insert Table 6 Here]

Table 6 displays the results of the OLS regressions of effort on prize structures with the Grouped-Winners contest as the base treatment. We also control for any possible carryover effects from the first contest treatment with an order effect dummy. The pattern of results is identical to those in Experiment 1. There is no difference in effort between the Grouped-Winners and the Ranked-Winners contests for the pooled data ( $t=-0.02$ ,  $p=0.981$ ).<sup>14</sup> Moreover, this result is consistent across each of the five blocks. More importantly, the power of the test is 0.92, which is sufficiently high. Next, a repeated-measures ANOVA shows no difference in effort between the two contests ( $F_{1,47}=0.001$ ,  $p=0.982$ ). Moreover, using the average effort of each subject as the dependent variable, the nonparametric Wilcoxon Signed-Rank tests reveal no difference in effort between the Ranked-Winners and the Grouped-Winners contests ( $Z=-0.164$ ,  $p=.870$ ). Hence, the results of Experiment 2 confirm that there is no difference in effort levels between the Grouped-Winners and Ranked-Winners contests. Finally, the Nonlinear Least Squares estimate of the implied aggregate risk aversion coefficient from the effort data is 0.558 ( $t=3.31$ ,  $p=0.002$ ), which is close to our measure of 0.55 using the lottery procedure, suggesting that our measure is robust.

Overall, the two laboratory experiments show that the prize structure of a sales contest does matter, but not exactly in the way existing marketing theory predicts. The optimal sales contest should indeed have multiple prizewinners, but having unique rank-ordered prizes does not boost sales effort.

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<sup>14</sup> The results of the OLS regressions used to test the hypotheses in both the laboratory experiments remain unchanged when we include the subjects' level of risk aversion as a covariate. Details are available from the authors upon request.

#### 4. FIELD EXPERIMENTS

We conduct two field experiments that are designed to test Hypotheses 1 and 2 further. These experiments deliver value to our research through serving as an external validity check because the environmental settings in the field experiments correspond to those which the marketing theory of sales contests is expected to apply. However, as we will further elaborate, the trade-off is that the field experiments do not meet the assumptions of the theoretical model of sales contests as well as the laboratory experiments.

*Subjects and Field Environment.* We recruited 60 salespeople who are responsible for fund raising activities at a public research university in the United States. These fundraising events include golf tournaments, career fairs, media advertising, and sponsorships for educational programs. All the salespeople received training in areas such as sales prospecting, rapport building, making sales presentations, and asking for orders. The salespeople are quite diverse in that 51% are female and 63% are non-Caucasian. The average salesperson is 23 years old, and the age range is 20 to 29 years. Salespeople have an average of 4.5 years of work experience, of which an average of 2.3 years is directly related to selling functions.

Each field experiment is designed to study a different hypothesis. Field Experiment 1 tests Hypothesis 1 by comparing sales outcomes in the One-Winner versus the Grouped-Winners contests. Field Experiment 2 involves a different selling task and tests Hypothesis 2 by comparing sales outcomes in the Grouped-Winners and Ranked-Winners contests.<sup>15</sup> In Field Experiment 1, the salespeople sold sponsorships to the business community through a golf tournament. The sponsorship products include individual player and team sign-ups for the golf

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<sup>15</sup> Due to limitations in the size of the sales force, we were unable to design an experiment that compares the three prize structures using the same selling task.

tournament. The full list of products and prices can be found in Table 7. In Field Experiment 2, salespeople solicited donations from companies to raise funds for the university and were each provided a list of two hundred potential sponsors that they could contact. The contest cycle in each experiment is six weeks. In all the sales contests, the salespeople received only one formal update about the sales dollars of the other contestants from the researchers (at the end of the fourth week into the contests). The results of the contests were announced only when both experiments were concluded. Besides the prizes in the sales contests, there were no other monetary incentives. The same group of 60 salespeople performed the two different selling tasks, which overlapped for four weeks, albeit with different sales peaks. To our knowledge, performing multiple selling tasks (each with its own incentives) is something common to salespeople. We would like to stress that both the selling tasks and their sales cycles are features of the fundraising tasks that the salespeople are supposed to undertake and were not constructed specially for this research.

[Insert Table 7 Here]

The field experiments have two advantages over the laboratory experiments, because the empirical setting is more “natural” along two dimensions. First, they involve real selling tasks by salespeople who had received formal sales training. Compared to the subjects in the laboratory experiments, trained salespeople could be more skillful in evaluating the trade-off between effort and rewards. Second, unlike in the laboratory experiments, we used the terms ‘sales contest’, ‘win’, ‘prizes’, and revealed the identities of each salesperson’s competitors when we introduced the contests to the salespeople, so that the competitive environment is more similar to that of sales contests conducted in companies.

While the selling environments described above provides a very clean test of the theory relative to most other company settings, it is still important to point out that there are features where the assumptions of the theoretical model are not tracked as closely, especially when compared to the laboratory setting (see Column 3 in Table 2). First, we were able to achieve only partial control over the assumption of homogeneity in sales productivity. Although each salesperson in the experiments underwent the same sales training program and the range of sales experience is relatively narrow, there may be substantial heterogeneity across salespeople on other important dimensions of sales productivity (e.g., personality factors and selling approach). Moreover, salespeople may believe that they are competing against others who may be more or less skilled in selling. Second, while sales effort is the primary outcome measure in the theoretical model, we are unable to use this measure as it is extremely difficult to observe and quantify sales effort in the field environment. This means that only sales outcomes can be used to determine if there are differences between prize structures. Furthermore, a feature of the field test is that we cannot generate point predictions for dollar sales for the field experiments. To pin these down, one would need to have accurate measures of the sales-effort function and the cost of effort function, which in turn requires a good measure of sales effort to begin with.<sup>16</sup> Hence our hypotheses and the statistical analyses are limited in that there are only directional in nature (because even if they are not observed, the point predictions do exist). Finally, the sample size in our study is relatively small, which will limit the power of the statistical tests. Our results must thus be interpreted with these caveats in mind.

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<sup>16</sup> As part of the selling tasks, salespeople were required to keep a record of the sales calls (number of calls, duration, and level of progress in the selling phase) they make to each prospect. This measure does not fully capture all aspects of sales effort (e.g. quality of the conversations). We note that the lack of point predictions is not specific to our experimental design, but will be a feature of virtually all field settings.

*Contest Design.* To design prize distributions for the Grouped-Winners and the Ranked-Winners prize structures that are theoretically optimal, we estimated the salespeople's aggregate level of risk aversion using Holt and Laury's (2002) procedure. 56 out of the 60 salespeople made the six lottery decisions with the payoffs given in Table 3 multiplied by 1.5 times. Three salespeople were then randomly selected and paid according to their lottery decisions for one of the six questions. The estimated aggregate risk aversion parameter,  $\alpha$ , is 0.47 (Log-Likelihood=-171.9  $\lambda=0.13$ ), which is not significantly different from  $\alpha=0.50$  ( $\chi^2=0.6$ , d.f.=1,  $p=0.439$ ).

In Field Experiment 1, which compares the One-Winner and Grouped-Winners prize structures, the 60 salespeople were randomly divided into four contest groups, with two contest groups for each prize structure. The number of contestants,  $N$ , in each contest group was 15. We deliberately chose  $N$  to be larger than 8, the contest size in the laboratory experiments, because we wanted to see if the empirical outcomes would be similar for a larger sales force. The total prize money in each contest group was  $B=\$300$ . In each of the One-Winner contest groups, the salesperson with the highest dollar sales received \$300, while the other fourteen received no monetary rewards. In the Grouped-Winners contest groups,  $w_{GW}^* = 5$ , so the salespeople who were ranked from 1<sup>st</sup> to 5<sup>th</sup> in each contest group received \$60 each. The prize distributions for the contests are also displayed in Table 8.

[Insert Table 8 Here]

In Field Experiment 2, which compares the Ranked-Winners and Grouped-Winners prize structures, the sixty salespeople were again randomly divided into four contest groups of fifteen each (salespeople do not compete against the same set of contestants in the two selling tasks). Again, there were two contest groups for each prize structure. The lower half of Table 8 displays

the prize distributions for the contests. The total prize money in each contest group was  $B=\$200$ , which is lower than in Field Experiment 1 because past data indicate that dollar sales are higher in the golf tournament. The optimal design for the Ranked-Winners contest has 6 prizewinners, and the prize distribution is  $\{\$70, \$51, \$36, \$23, \$13, \$7\}$ .<sup>17</sup> For the Grouped-Winners prize structure, since the optimal number of winners is  $w_{GW}^* = 5$ , salespeople ranked 1<sup>st</sup> to 5<sup>th</sup> in each contest group received \$40 each.

*Results.* For every contest in each experiment, there are a total of 30 observations (2 contest groups with  $N=15$  each). The average dollar sales for each contest in the two experiments are also reported in Table 8. In Field Experiment 1, the average dollar sales in the Grouped-Winners contest are \$1391, which is directionally higher than the average of \$897 in the One-Winner contest. In Field Experiment 2, average sales in the Ranked-Winners and Grouped-Winners contests are \$333.33 and \$358.33, respectively.

We perform Likelihood-Ratio tests to check for statistical differences in average sales using the theoretical assumption of  $s_i \sim \text{Logistic}(\mu(\cdot), \pi^2\beta^2(\cdot))$ , where  $(\cdot)$  represent a prize structure. First, the means and variances for each prize structure are freely estimated. Then the log-likelihood in the unrestricted model is compared to that of a restricted model where the average sales of the prize structures are constrained to be equal. The results are shown in Table 9. In Field Experiment 1, the Likelihood-Ratio test reveals that average dollar sales in the Grouped-Winners contest is higher relative to the One-Winner contest. Specifically, the log-likelihood drops from -483.0 in the unrestricted model to -486.5 under the constraint of  $\mu_s(\text{GW}) = \mu_s(\text{1W})$  ( $\chi^2=7.0$ , d.f.=1,  $p=0.008$ ). In Field Experiment 2, the Likelihood-Ratio test indicates that there is

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<sup>17</sup> Strictly speaking, the optimal Ranked-Winners design prescribes awarding \$6 to the salesperson ranked 6<sup>th</sup> and \$1 to the salesperson ranked 7<sup>th</sup>. We felt that the \$1 prize was too low and awarded \$7 to the 6<sup>th</sup> place.

no difference in the average sales between the Ranked-Winners and Grouped-Winners contests. The log-likelihood in the full and the restricted models (the latter with the constraint  $\mu_s(\text{RW}) = \mu_s(\text{GW})$ ) are -398.955 and -398.972 respectively, and the chi-square statistic is 0.034 (d.f.=1,  $p = 0.854$ ).

The above pattern of results is also supported by Wilcoxon Rank-Sum tests. In Field Experiment 1, sales in the Grouped-Winners contests are indeed higher relative to when there is only one prizewinner ( $Z=3.00$ ,  $p = 0.003$ ). In Field Experiment 2, there are no differences in sales between the Ranked-Winners and Grouped-Winners contests ( $Z=-0.44$ ,  $p = 0.660$ ).<sup>18</sup> Finally, in Field Experiment 1, the bootstrapped 95% confidence interval of the difference in average sales between the Grouped-Winners and One-Winner contests is [72, 1048]. The same measure for the Ranked-Winners and Grouped-Winners contests in Field Experiment 2 is [-75, 124], which includes 0.

Since each salesperson performed the two different selling tasks, we can use a correlation analysis of the salespeople's ranks in the two contests they participated in to examine if there is strong evidence of heterogeneity in sales productivity. The Spearman rank correlation coefficient in our experiments is 0.246 and is not significantly different from zero ( $p = 0.063$ ), suggesting that heterogeneity might not be a key driver of the results.

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<sup>18</sup> The results do not change if we use  $t$ -tests instead of the Wilcoxon Rank Sum tests: sales are higher in the Grouped-Winners contest relative to the One-Winner contest ( $t=2.01$ ,  $p=0.049$ ) and there are no differences in sales between the Ranked Winners and Grouped-Winners contest ( $t=-0.491$ ,  $p=0.625$ ). The levels of "observed power" of the  $t$ -tests, that is, power measures computed using the differences in the *empirical* means, are 0.51 and 0.08 in Field Experiments 1 and 2 respectively. We note that these measures are not as accurate as the ones we computed for the laboratory experiments, where we have the theoretical predictions of effort (these predictions exists but are unobservable in the field context). Furthermore, Hoenig and Heisey (2001) highlight the problem of drawing inferences from "observed power" - because there is a direct relationship between the  $p$ -value and observed power, an observed null effect will very rarely have high power.

Overall, the findings of the field experiments are consistent with those of the laboratory experiments: Introducing multiple prizewinners into sales contests increases sales revenue. However, introducing unique rank-ordered prizes into multiple-winner contests does not boost sales revenues.

## **5. DISCUSSION AND CONCLUSION**

Sales contests are implemented regularly in companies, but there has been little theoretical and no empirical research on the question of what should be the optimal prize structure in a sales contest. In practice, sales managers have been calling for help on how to formulate and measure the effectiveness of their sales contests (Litsikas 2006). However, as demonstrated by the 2001 Federation Study, these “black box” characteristics have not stopped sales managers from spending more and more money on sales contests. All the while, managers are left with limited means of evaluating the impact of their contests (Brodsky 2003). As questions regarding contest design increase along with corporate spending on sales contests, the need for specific direction and quality measurement methods becomes even more pressing.

This paper contributes to marketing by presenting the first set of empirical studies that address these issues. The empirical studies consist of two laboratory experiments where subjects make decisions that closely parallel the effort-reward trade-offs faced by salespeople in sales contests and two field experiments where trained salespeople are randomly assigned to participate in sales contests with different prize structures. We believe that this empirical strategy is novel and the laboratory and field experiments, taken together, create an empirical test that is both internally and externally valid. The results of the laboratory and field experiments are remarkably consistent and indicate that the prize structure of a sales contest is indeed an

important determinant of sales effort: Specifically, sales contests with multiple prizewinners motivate salespeople to expend more effort. However, contrary to the prediction of the existing theory of sales contests, there is no need to have unique rank-ordered prizes in contests with multiple-winners – keeping the prize values identical across prizewinners does not result in a significant drop in sales effort.

Our findings imply that designing the optimal sales contest is a less complex task than prescribed – managers need only determine the optimal number of winners in the Grouped-Winners contest. This can be done once the number of salespeople in a contest is known and the aggregate level of risk aversion of the contestants is measured using the lottery choice procedure we used in this paper. Moreover, because calculating optimal prize spreads among prizes is less important than suggested by theory, managers can also opt more readily for non-cash prizes, where the perceived differences in monetary values of the prizes may be less precise, without worrying about a reduction in effort.

Many authors in the practitioner literature have observed that the same few salespeople tend to win all of a firm's sales contests and have posed the question of how to motivate more than just these few top-performers (Bishop 1999; Farber 1994). Our research suggests that having multiple winners with identical prizes in sales contests can enhance sales performance through raising overall morale in the sales force. The overall morale in a One-Winner contest is likely to be low because while the winner is ecstatic, the rest of the sales force may wallow in defeat. Creating multiple prizes allows more salespeople to be “a winner”, and having prizes of identical values can raise the morale of salespeople who are not the top-performers because they have the opportunity to obtain equal recognition. Managing these morale levels is important

because they can affect sales effort in subsequent periods. Future researchers should examine this further by building dynamics into their models to test the long term impact of sales contests on sales effort and performance.

As cooperation and teamwork becomes increasingly important in sales organizations (Cummings 2007), it is also important that the prize structure of a sales contest does not endanger cooperation within the sales force. Because of the large differences in prize values across ranks, the One-Winner and Ranked Winners contests can create a hyper-competitive and cut-throat environment. The Grouped-Winners contest may create the most cooperative contest environment since salespeople who know that they will be a prizewinner no longer face incremental pressure to boost sales. Therefore, they may be more willing to spend time helping other salespeople without adversely affecting their own prize earnings.

We would like to make several observations about the experimental design and findings of this paper that should also stimulate further research. First, the results of both laboratory experiments suggest a small but consistent underinvestment in effort. The underinvestment in effort may be explained by a recent finding that decision-makers overweight the costs of up-front payments (Ho and Zhang 2008) – similarly, in sales contests, sales effort can be viewed as an up-front cost since it has to be expended before the contest outcomes are known.<sup>19</sup> More interestingly, a major finding in our paper is that the degree of underinvestment is higher in the Ranked-Winners contest, so that effort levels are not different from that of the Grouped-Winners contest. This result is surprising from an economics perspective because the rank-ordered prizes provide an incentive effect to achieve the highest ranks possible. However, there are two

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<sup>19</sup> If we allow the cost of effort parameter  $k$  to be scaled by a multiplicative term  $\mu$  (with  $\mu > 1$  since effort costs are over-weighted), then in the first laboratory experiment, the Maximum Likelihood estimate of  $\mu$  assuming that effort is normally distributed with the expression for equilibrium effort in equation 1 as the mean, is 1.074.

behavioral forces that can cancel this effect. The first is a reference-dependent effect based on research by Medvec et al. (1995), who found that Olympic silver medalists appeared more unhappy than bronze medalists because the former compare their outcome with the possibility that they could have won the gold medal – applying this to sales contests, differentiating prizewinners through rankings may reduce effort because the utilities from prizes that are below highest rank may be perceived to be lower if salespeople compare their rankings and prizes to those at higher ranks.<sup>20</sup> Conversely, in the Grouped-Winners contest, contestants know that there will be no such utility losses because all prizewinners will feel like they have the same level of achievement. Second, salespeople may withhold effort in a Ranked-Winners contest if they are not confident about achieving the top rank, since the prizes associated with lower ranks are comparatively smaller. This effect will be greater if the prize spreads are convex (i.e., absolute prize values are smaller as one moves from the top rank to lower ranks), since a larger proportion of the total prize money is concentrated in the highest ranks. As we suggested earlier, the Grouped-Winners contest may motivate those who are not confident about getting first place to increase effort, because coming in second or third will be equally rewarding. We believe that the study of psychological and social effects of sales contests is one of most fruitful areas of future research. For example, would a contest with more winners than losers motivate contestants to put in more effort so that they would not be in the minority? If contests are repeated for the same set of salespeople, could there be pressure on winners to avoid losing subsequently, or would salespeople who did not win in previous contests be even more motivated to win to avoid embarrassment? These effects may be moderated by the degree to which salespeople make social comparisons in the organization.

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<sup>20</sup> We are grateful to the editor-in-chief for this insight.

Next, we note that the participants in our research exhibited a moderate amount of risk aversion over the lottery stakes, which is the theoretical basis for the empirical finding that prize structures with multiple prizewinners yield higher effort. It is important to point out that while the cash prizes in the contests were the sole monetary reward for expending sales effort in the experiments, it is not so in companies, as sales contests are used on top of existing compensation schemes such as salary and commissions. Hence, when measuring risk aversion using lottery stakes that span the range of monetary outcomes of the contest, the degree of risk aversion should be lower if salespeople rationally integrate their major sources of income into their utility for monetary wealth. On the other hand, there is empirical evidence that decision-makers engage in “narrow framing”, that is, they evaluate the attractiveness of uncertain outcomes in isolation and do not integrate other sources of wealth into their decision calculus, thus exhibiting moderate levels of risk aversion over relatively small monetary stakes (Barberis, Huang and Thaler 2006). Similarly, salespeople’s risk preferences over prize outcomes may be separately evaluated from other sources of compensation.<sup>21</sup> More research should be directed to study the factors that impact the degree to which salespeople engage in “narrow framing” in evaluating the rewards of supplementary compensation such as prizes from sales contests or bonuses for meeting sales targets, because the optimal design of these compensation schemes depends critically on the level of risk aversion assumed by managers. In sales contests, the degree of “narrow framing” (and the measured level of risk aversion) may depend on how motivated salespeople are by the contests, which is not only a function of the total prize money, but also on how the contest will

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<sup>21</sup> In both the laboratory experiments, there is also no evidence that the degree of risk aversion is lower with an increase in income earned as the experiment progressed. For example, in Experiment 1, the implied aggregate risk aversion from the effort data in the first eight rounds is 0.498, while the same measure is 0.514 in the last seven rounds. The two estimates are not significant different ( $F_{1,71}=0.025, p=0.875$ ). This result also holds from different partitions of the data. Moreover, it can be argued that the subjects in our studies engaged in narrow-framing, since they should be also close to risk-neutrality if they evaluated the options based on their overall wealth.

be implemented, such as whether salespeople will receive frequent reminders about the contest and updates on rankings.

An important qualification of our findings is that they are based on empirical tests that attempt to control for heterogeneity in the sales productivity of salespeople – in the laboratory experiments the subjects are completely homogeneous in their sales productivity, while in the field experiments, the participants are relatively homogeneous based on their narrow range of sales experience and lack of territories. Since the typical sales force in companies are likely to be more heterogeneous in their sales productivity, we discuss how our research findings can extend to these environments, particularly when it is difficult for managers to create more homogeneous contests by either developing a metric that adjusts for territorial differences when ranking the salespeople or designing separate contests for different groups of salespeople. First, we note that as long as salespeople are risk-averse, the optimal number of winners in a sales contest still exceeds one. Moreover, we expect the number of prizewinners to increase if the sales productivities of the contestants are different because managers need to motivate the “disadvantaged” salespeople to expend effort, which will in turn induce the “advantaged” salespeople to do so.<sup>22</sup> Second, we expect the Grouped-Winners contest to perform as well, if not better, than the Ranked-Winners contest, so that the finding of introducing unique rank-ordered prizes into contests with multiple prizewinners does not boost effort should continue to hold. A comparison of the model that assumes homogeneity in sales productivity and tournament models in the economics literature that allow for heterogeneity (available in the second section of the Web Appendix) shows that while economic theory still predicts a positive marginal effect of prize spreads on effort, this effect is weaker when salespeople are heterogeneous in sales abilities

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<sup>22</sup> A possible exception to this is when the proportion of disadvantaged salespeople is very small and managers want to motivate the advantaged agents.

or territorial advantages. Put differently, the incentive effect of having prize spreads through implementing a Ranked-Winners contest is predicted to be even smaller if there are differences in sales productivity among the contestants.

As mentioned earlier, our empirical tests do not control for heterogeneity in risk preferences among contestants and bounded-rational behavior. The reason was that these factors are present and are difficult to control in virtually any empirical setting, so the theory must survive these in order to be useful. The substantial dispersion in effort choices in the laboratory experiments suggests that heterogeneity in risk preferences and bounded-rational behavior are indeed present. While the focus of our paper was to study aggregate behavior across different prize structures, future models of sales contests should incorporate these factors so that individual behavior can be explained better. Approaches that relax the Nash equilibrium solution concept, such as incorporating noisy best-response (Lim and Ho 2007) or heterogeneity in levels of strategic thinking (Camerer, Ho and Chong 2004) are particularly promising as these models can predict dispersion in effort decisions even when salespeople are homogeneous in sales productivity.

Finally, in the field experiments we provided all the contestants with only one informational update about the rankings and dollar sales of other contestants during the contest cycle. We did not study whether the provision of feedback or how the frequency and type of feedback affects sales effort. This question is one that managers confront when implementing sales contests, and remains an open area of research.

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**Table 1: Optimal Contest Designs and Relative Effort in the One-Winner and Grouped-Winners Contests**

	(1)	(2)	(3)	(4)
	Ranked-Winners Contest	Grouped-Winners Contest	Relative Effort of the	Relative Effort of the
	$\{P_1, P_2, \dots, P_{W^*}\}$	$\{P_1, P_2, \dots, P_{W^*}\}$	One-Winner Contest <sup>+</sup>	Grouped-Winners Contest <sup>+</sup>
	(\$)	(\$)	(%)	(%)
<u>8 contestants</u>				
$\alpha=0.25$	{49, 31, 16, 4}	{33.3, 33.3, 33.3}	58.7	95.5
$\alpha=0.50$	{58, 30, 11, 1}	{33.3, 33.3, 33.3}	76.4	94.5
$\alpha=0.75$	{77, 20, 3}	{50, 50}	93.8	95.6
<u>15 contestants</u>				
$\alpha=0.25$	{30, 23, 18, 13, 9, 5, 2}	{16.7, 16.7, 16.7, 16.7, 16.7, 16.7}	39.0	96.0
$\alpha=0.50$	{35, 26, 18, 11, 6, 3, 1}	{20, 20, 20, 20, 20}	59.1	94.5
$\alpha=0.75$	{52, 29, 13, 5, 1}	{33.3, 33.3, 33.3}	84.8	95.6

<sup>+</sup> The parameters used are  $B=\$100$ ,  $\beta=1$  and  $k=10$ . Relative effort refers to sales effort relative to that in the optimal Ranked-Winners contest.

**Table 2: Criteria for a Valid Empirical Test and the Relative Strengths of the Laboratory and Field Experiments**

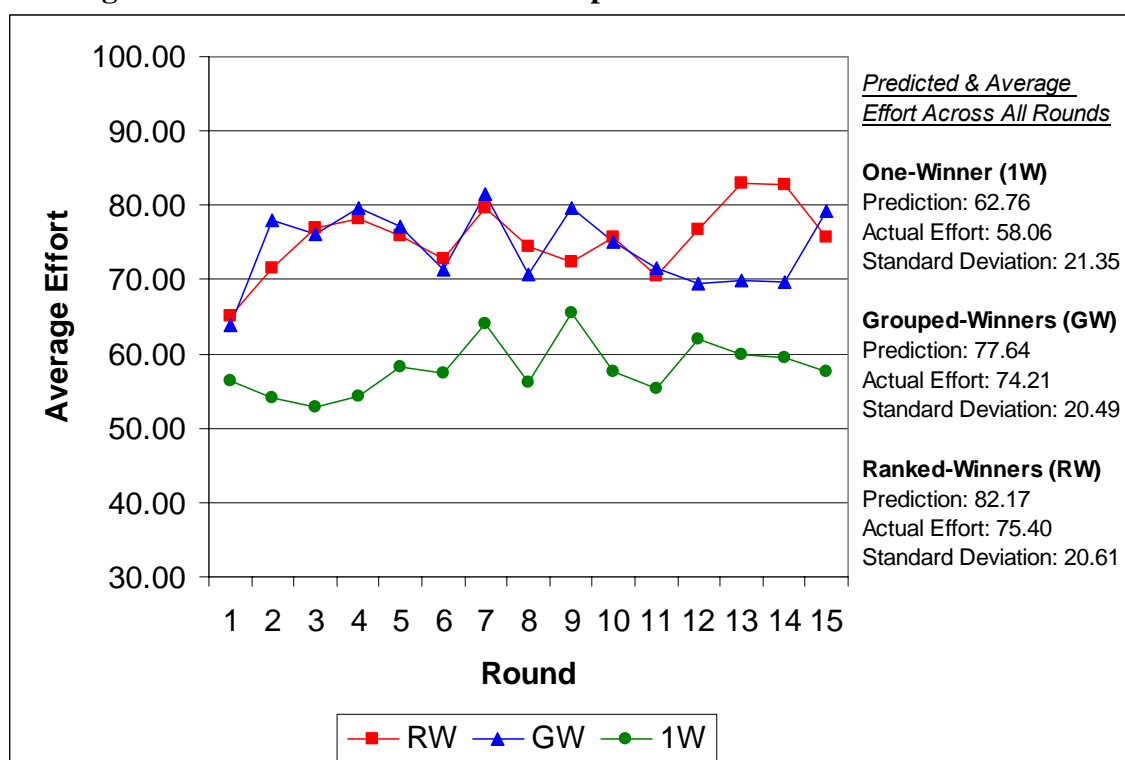
(1) Criteria	(2) Laboratory Experiments	(3) Field Experiments
Optimal Prize Distributions for the Grouped and Ranked-Winners Contests	<p>Yes</p> <p>Specifications:  <math>N=8</math>  <math>\alpha=0.50</math> (measured for Experiment 1)  <math>\alpha=0.55</math> (measured for Experiment 2)  <math>B=\\$15</math> per round in Experiment 1,  <math>\\$6.75</math> per round in Experiment 2</p> <p>Participation constraint satisfied:  a) No other monetary incentives  b) Expected Utility is positive</p>	<p>Yes</p> <p>Specifications:  <math>N=15</math>  <math>\alpha=0.50</math> (measured)  <math>B=\\$300</math> in Experiment 1,  <math>\\$200</math> in Experiment 2</p> <p>Participation constraint satisfied:  a) No other monetary incentives</p>
Effort Directly Observable	<p>Yes</p> <p>The following must be specified:  <math>h(e)=e</math>  <math>\varepsilon_i \sim \text{Logistic}(0, \pi^2 \beta^2 / 3)</math>, <math>\beta=30</math>  <math>c(e)=ke^2</math>, <math>k=0.0002</math></p>	<p>No</p> <p>This is because <math>h(e)</math>, <math>\beta</math>, &amp; <math>c(e)</math> cannot be accurately determined</p>
Homogeneity of Salespeople		
Sales productivity	<p>Close Control</p> <p>Control Mechanism: <math>h(e)</math>, <math>c(e)</math> and <math>\beta</math> are identical and common knowledge</p>	<p>Partial Control</p> <p>There may be heterogeneity in sales productivity across contestants.  Control Mechanism:  Each salesperson undergoes the same sales training courses, range of sales experience (number of years) is small</p>
Preferences over monetary prizes	<p>Not controlled</p> <p>Preferences may be heterogeneous. Risk aversion parameter (<math>\alpha</math>) used is an aggregate measure</p>	<p>Not controlled</p> <p>Preferences may be heterogeneous. Risk aversion parameter (<math>\alpha</math>) used is an aggregate measure</p>
Trained Salespeople performing Real Selling Task	No	Yes

**Table 3: Lottery Choice Questions for Measuring Risk Aversion**

	(1) Option A	(2) Option B	(3) Difference in Expected Value (A-B) (not provided to subjects)
1.	40% chance of \$20 and 60% chance of \$16	40% chance of \$38.50 and 60% chance of \$1.00	\$1.60
2.	50% chance of \$20 and 50% chance of \$16	50% chance of \$38.50 and 50% chance of \$1.00	-\$1.75
3.	60% chance of \$20 and 40% chance of \$16	60% chance of \$38.50 and 40% chance of \$1.00	-\$5.10
4.	70% chance of \$20 and 30% chance of \$16	70% chance of \$38.50 and 30% chance of \$1.00	-\$8.45
5.	80% chance of \$20 and 20% chance of \$16	80% chance of \$38.50 and 20% chance of \$1.00	-\$11.80
6.	90% chance of \$20 and 10% chance of \$16	90% chance of \$38.50 and 10% chance of \$1.00	-\$15.15

**Table 4: Theoretical Predictions for the Laboratory Experiments**

Prize Structure	Optimal Design $\{P_1, P_2, \dots, P_{W^*}\}$	Effort ( $e^*$ )	Relative Effort	Expected Utility
<i>Experiment 1</i>				
One-Winner	{15.00}	62.76	76.4%	0.18
Grouped-Winners	{5.00, 5.00, 5.00}	77.64	94.5%	0.47
Ranked-Winners	{8.75, 4.46, 1.61, 0.18}	82.17	100%	0.34
<i>Experiment 2</i>				
Grouped-Winners	{5.00, 5.00, 5.00}	76.50	93.8%	0.48
Ranked-Winners	{9.16, 4.33, 1.39, 0.12}	81.59	100%	

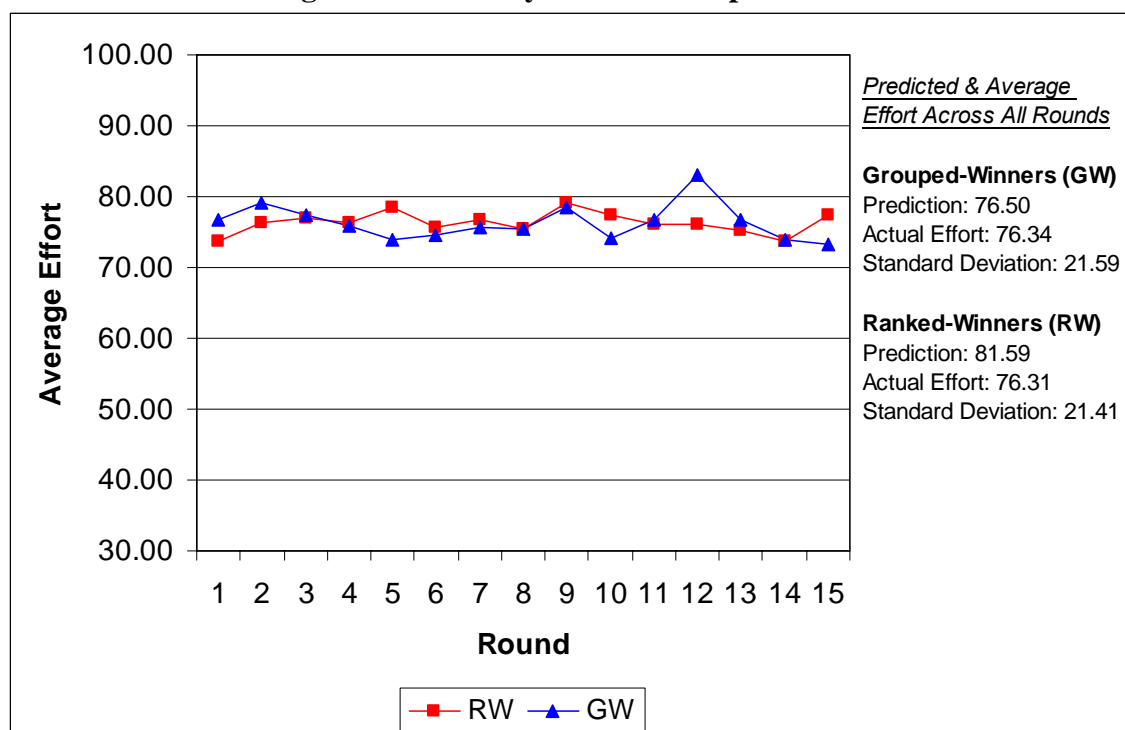
**Figure 1: Prize Structures with Multiple Winners Lead to Greater Effort**

**Table 5: Having Multiple Prizewinners Boosts Effort, But Unique Rank-Ordered Prizes Do Not**

	Overall	Block 1	Block 2	Block 3	Block 4	Block 5
<i>Test of Hypothesis 1</i>						
Constant (Base=One-Winner)	58.06* (2.35) <sup>†</sup>	54.46* (2.75)	56.64* (3.11)	61.90* (3.00)	58.31* (3.08)	59.01* (3.74)
Grouped-Winners	16.15* (3.20)	18.28* (3.42)	19.39* (4.27)	15.42* (4.56)	13.74* (4.19)	13.92* (5.01)
Ranked-Winners	17.33* (3.30)	16.68* (3.95)	19.00* (4.68)	13.56* (3.93)	16.00* (4.75)	21.43* (4.81)
<i>Test of Hypothesis 2</i>						
Constant (Base=Grouped-Winners)	74.21* (2.17)	72.74* (2.03)	76.03* (2.92)	77.32* (3.44)	72.04* (2.84)	72.93* (3.33)
One-Winner	-16.15* (3.20)	-18.28* (3.42)	-19.39* (4.27)	-15.42* (4.56)	-13.74* (4.19)	-13.92* (5.01)
Ranked-Winners	1.19 (3.17)	-1.60 (3.49)	-0.39 (4.55)	-1.86 (4.27)	2.26 (4.60)	7.51 (4.49)
Observations	1080	216	216	216	216	216
Clusters	72	72	72	72	72	72
$R^2$	0.1263	0.1608	0.1610	0.0992	0.0980	0.1471

<sup>†</sup> Standard errors are shown in the parentheses

\* Significant at the 5% level

**Figure 2: Summary Results of Experiment 2****Table 6: Experiment 2 Confirms That Unique Rank-Ordered Prizes Do Not Matter**

	Overall	Block 1	Block 2	Block 3	Block 4	Block 5
Constant (Base= Grouped-Winners)	74.95* (2.30) <sup>†</sup>	76.42* (2.37)	74.57* (2.56)	74.20* (2.54)	75.99* (2.63)	73.54* (3.36)
Ranked-Winners	-0.03 (1.47)	-2.19 (2.18)	2.05 (2.41)	0.65 (2.14)	-1.54 (2.47)	0.85 (2.80)
Carryover Effect (From First Contest Treatment)	2.80 (1.47)	2.74 (2.18)	0.41 (2.41)	4.60* (2.14)	4.07 (2.47)	2.17 (2.80)
Observations	1440	288	288	288	288	288
Clusters	48	48	48	48	48	48
$R^2$	0.0042	0.0075	0.0024	0.0123	0.0103	0.0025

<sup>†</sup> Standard errors are shown in the Parentheses

\* Significant at the 5% level

**Table 7: Product Line and Prices in Field Experiment 1**

Product Description	Price
Individual Player	\$150
Driving Range Sponsor	\$250
Golf Towel Sponsor	\$500
Foursome Team	\$500
Dinner Sponsor	\$500
Snack/Drink Sponsor	\$500
Sign Sponsor	\$1,000

**Table 8: Contest Designs and Summary Outcomes of Field Experiments**

Design	Optimal Design	Average Sales	Standard Deviation
	$\{P_1, P_2, \dots, P_{w^*}\}$		
<i>Field Experiment 1</i>			
One-Winner	{300}	\$897.07	778.31
Grouped-Winners	{60, 60, 60, 60, 60}	\$1391.00	1096.97
<i>Field Experiment 2</i>			
Grouped-Winners	{40, 40, 40, 40, 40}	\$358.33	181.98
Ranked-Winners	{70, 51, 36, 23, 13, 7}	\$333.33	211.05

**Table 9: Results of Field Experiments Confirm Findings of Laboratory Experiments**

Models	Log-Likelihood	Chi-Square Statistic	<i>p</i> -value
<i>Field Experiment 1</i>			
Full Model	-483.0	-	-
Restriction:			
$\mu_s(\text{GW}) = \mu_s(\text{1W})$	-486.5**	7.0	0.008
<i>Field Experiment 2</i>			
Full Model	-398.955	-	-
Restriction:			
$\mu_s(\text{RW}) = \mu_s(\text{GW})$	-398.972	0.034	0.854

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\*\* significant at the .01 level

## Web Appendix

### Section A1 – Important Features of the Marketing Theory of Sales Contest

#### *A1.1 Salesperson's Behavior*

Please refer to the model setup introduced in the paper. Given the assumptions, each salesperson evaluates the tradeoff between expending effort and the probability of attaining monetary rewards given the prize structure. The expected utility of the salesperson is

$$(1) \quad EU(R_i, e_i) = \sum_{j=1}^N \frac{P_j^\alpha}{\alpha} \times \Pr(R_i = P_j) - c(e_i).$$

The first term in (1) denotes the expected reward for the salesperson, which is obtained by multiplying the value of the prize for the  $j$ th-rank with the probability of attaining that rank, summed across the  $N$  possible ranks.

Each salesperson chooses the optimal level of effort by maximizing their expected utility given in equation (1). Further using the assumption that all salespeople have identical and rational belief structures, so that all salespeople will expend  $e^*$ , the probability that a salesperson attains the  $j$ th rank is

$$(2) \quad \Pr(R_i = P_j) = \int_{\varepsilon_i} \binom{N-1}{j-1} \times [1 - F(y)]^{j-1} \times F^{N-j}(y) \times f(\varepsilon_i) d\varepsilon_i,$$

where  $y = h(e_i) - h(e^*) + \varepsilon_i$ , while  $F$  and  $f$  are the cumulative probability and probability densities of  $\varepsilon_i$  respectively. The symmetric Nash-equilibrium effort for a salesperson is given by the solution to the following first-order condition:

$$(3) \quad \sum_{j=1}^N \frac{P_j^\alpha}{\alpha} \frac{\partial \Pr ob(R_i = P_j)}{\partial e_i} (e_i = e^*) - c'(e^*) \equiv 0.$$

When sales outcomes follow the logistic density and  $h(e_i) = e_i$ , Kalra and Shi (2001) showed that the marginal probability of obtaining the prize associated with the  $j^{\text{th}}$  rank is equal to  $(N-2j+1)/[\beta N(N+1)]$ . Using the common function specification of  $c(e_i) = ke_i^2$ , the closed-form equilibrium effort level of each salesperson for a given prize structure is<sup>24</sup>

$$(4) \quad e^* = \sum_{j=1}^N \frac{P_j^\alpha (N-2j+1)}{2k\alpha\beta N(N+1)}.$$

### A1.2 Manager's Decision

The manager chooses the prize structure that maximizes the firm's expected profits. Letting  $m$  be the firm's margin on every sales dollar, the manager solves the following constrained maximization problem:

$$(5) \quad \max_{\{P_1, P_2, \dots, P_N\}} E\pi = m \times N \times s(e^*) - B$$

$$(6) \quad \text{s.t.} \quad e^* = \sum_{j=1}^N \frac{P_j^\alpha (N-2j+1)}{2k\alpha\beta N(N+1)};$$

$$(7) \quad \frac{1}{N} \sum_{j=1}^N \frac{P_j^\alpha}{\alpha} - k(e^*)^2 \geq u_0;$$

$$(8) \quad \sum_{j=1}^N P_j = B; \text{ and}$$

$$(9) \quad P_j \geq 0.$$

The four constraints in equations (6) to (9) are interpreted as follows: Equation (6) says that the manager is incorporating the fact that salespeople will choose the symmetric Nash-equilibrium effort level given a prize structure when designing the optimal contest. Equation (7) says that the

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<sup>24</sup> These specifications are also used in Kalra and Shi (2001) and Bull, Schotter and Weigelt (1987). The optimal prize structure is not affected by these functional assumptions.

prize structure must be designed so that the salesperson's expected utility from participating in the contest is only as high as some level of utility,  $u_0$ , which is typically influenced by other selling tasks and incentive structures. Equations (8) and (9) limit the total prize value to the budget,  $B$ , and the prize values to be nonnegative, respectively.

### Section A2 – Analyzing the Effect of Heterogeneity on Sales Contest Design

We discuss how the incentive effect of prize spreads on effort differs when salespeople are heterogeneous in their sales productivity, relative to the case when they are homogeneous. To do so, we compare the results of tournament models in the economics literature that allow for heterogeneity with a simplified version of the model (which assumes homogeneity) we present in the paper. We show that while economic theory still predicts a positive marginal effect of prize spreads on effort, this effect is weaker when salespeople are heterogeneous in sales abilities or territorial advantages. This insight suggests that the positive incentive effect from moving from a Grouped-Winners contest to a Rank-Winners contest through increasing the spreads between prizes is smaller when sales people differ in their sales productivity.

We analyze a simplified version of the model presented in the paper. Consider a two-contestant model with risk-neutral salespeople. The results do not change qualitatively if salespeople are risk averse. Let the prizes corresponding to the two ranks be  $P_1$  and  $P_2$ , where  $P_1 > P_2 \geq 0$ . The utility of salesperson  $i$  ( $i=1,2$ ) is  $U_i(P_i, e_i) = P_i - ke_i^2$ , where  $ke_i^2$  is the cost-of-effort function. Sales output is given by  $s(e_i) = e_i + \varepsilon_i$ , and for simplicity  $\varepsilon_i$  is assumed to be distributed independently and uniformly over the interval  $[-q, +q]$ , where  $q > 0$ . In this case of homogeneous salespeople, it can be shown that the symmetric Nash equilibrium sales effort is

given by  $e^* = (P_1 - P_2)/4kq$  (see Bull et al. 1987 for a detailed derivation). This expression is also shown in Table A1.

Next, we consider the results of tournament models that allow for heterogeneity in sales productivity. There are two ways to capture heterogeneity in sales productivity. First, one can allow the cost of effort to be different across salespeople. This type of contest is also known as an “uneven contest”. In our analysis, the only change we make to the basic model above is to assume that the cost-of-effort function for the less productive salesperson is  $2ke_i^2$ . Second, one can capture differences in territorial advantages by adding a term  $a > 0$  (with  $a < 2q$ ) to the sales output of the more productive salesperson, so that it becomes  $s(e_i) = e_i + a + \varepsilon_i$ . This type of contest is also known as an “unfair contest”. Keeping all the other assumptions identical to the model setup for the homogeneous case above, the Nash equilibrium effort levels for salespeople in the uneven and unfair contests can be derived and are shown in Table A1. The detailed derivations of the equilibrium effort levels for the uneven and unfair contests are found in Bull et al. (1987) and Weigelt et al. (1989) respectively. Note that in the unfair contest, both salespeople expend the same level of effort even though their sales productivity is different.

To examine the incentive effect of prize spreads on effort, we take the derivative of effort with respect to the prize spread  $(P_1 - P_2)$ , that is, we derive  $\partial e^* / \partial (P_1 - P_2)$ . The expressions for  $\partial e^* / \partial (P_1 - P_2)$  for the homogeneous, uneven and unfair contests are shown in the last column of Table A1. We also note that  $\partial e^* / \partial (P_1 - P_2) > 0$  in all three cases, so that the incentive effect is always predicted to be positive. Next, we compare the relative strengths of the incentive effect for the homogeneous contest to each of the heterogeneous contests. We find that  $\partial e^* / \partial (P_1 - P_2)$  is always stronger in the homogeneous contest, so that increasing the prize spread between ranks

motivates salespeople more compared to the cases where the sales productivity between the contestants is different. The proofs of these results are shown below.

**Table A1: Equilibrium Effort and the Effect of Prize Spreads on Effort**

	Equilibrium Effort ( $e^*$ )	Effect of Spreads on Effort ( $\partial e^*/\partial(P_1 - P_2)$ )
Homogeneous Contest	$\frac{P_1 - P_2}{4kq}$	$\frac{1}{4kq}$
Uneven Contest		
More Productive Salesperson	$\frac{4q(P_1 - P_2)}{16kq^2 + P_1 - P_2}$	$\frac{64kq^3}{(16kq^2 + P_1 - P_2)^2}$
Less Productive Salesperson	$\frac{2q(P_1 - P_2)}{16kq^2 + P_1 - P_2}$	$\frac{32kq^3}{(16kq^2 + P_1 - P_2)^2}$
Unfair Contest	$\left[ \frac{1}{2q} - \frac{a}{4q^2} \right] \frac{P_1 - P_2}{2k}$	$\frac{1}{4kq} - \frac{a}{8kq^2}$

**Result 1:**  $\frac{\partial e_{Homogeneous}^*}{\partial(P_1 - P_2)} > \frac{\partial e_{More\ Productive}^*}{\partial(P_1 - P_2)} > \frac{\partial e_{Less\ Productive}^*}{\partial(P_1 - P_2)}$ .

Proof: We only need to show that the first inequality holds. To begin, we have

$$\begin{aligned} \frac{1}{4kq} &> \frac{64kq^3}{(16kq^2 + P_1 - P_2)^2} \\ \Rightarrow (16kq^2 + P_1 - P_2)^2 &> 256k^2q^4 \\ \Rightarrow 16kq^2 + P_1 - P_2 &> 16kq^2 \\ \Rightarrow P_1 - P_2 &> 0 \quad (\text{which is assumed in the model}). \end{aligned}$$

**Result 2:**  $\frac{\partial e_{Homogeneous}^*}{\partial(P_1 - P_2)} > \frac{\partial e_{Unfair}^*}{\partial(P_1 - P_2)}$ .

Proof:  $\frac{1}{4kq} > \frac{1}{4kq} - \frac{a}{8kq^2}$

$$\begin{aligned} \Rightarrow \frac{a}{8kq^2} &> 0 \\ \Rightarrow a &> 0 \quad (\text{which is assumed in the model}). \end{aligned}$$