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Optimal prizes in dynamic elimination contests: Theory and experimental evidence☆

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ABSTRACT

This paper investigates the implications of different prize structures on effort provision in dynamic (two-stage) elimination contests. Theoretical results show that, for risk-neutral participants, a structure with a single prize for the winner of the contest maximizes total effort, while a structure with two appropriately chosen prizes (a runner-up prize and a final prize) ensures incentive maintenance across stages. In contrast, a structure with two prizes may dominate a winner-takes-all contest in both dimensions if participants are risk-averse. Evidence from laboratory experiments is largely consistent with these predictions, suggesting that contest design should account for risk attitudes of participants.

1. Introduction

Contests are interactive decision situations in which agents compete by expending valuable resources to win a prize. Such situations appear in many different areas of economics and political economy – including the competition for bonus payments and promotions on internal labor markets, patent races in R&D, election campaigns, or military conflicts. Given the multiplicity of applications, it is not surprising that real world contests vary in several dimensions, for example, with respect to the number of participants, the number of prizes, or with respect to their structure. The effect of different modeling choices in these dimensions on behavior of contest participants has been studied extensively in theoretical work, which typically determines the optimal contest design with respect to a given optimality criterion under the simplifying assumption of common knowledge that all participants are rational and risk-neutral.[1] Two criteria are particularly prominent in the literature on optimal prizes in dynamic contests, namely the *maximization of aggregate incentives* (operationalized as the

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[1] See Konrad (2009) for a literature review.

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sum of efforts provided by all agents over all stages of the contest), and the *maintenance of incentives over all stages* of the contest (operationalized as constant individual efforts across stages). A common motivation for both objectives is that effort provision by contestants is valuable for the entity organizing the contest, henceforth called the contest designer. The maximization of aggregate incentives is a natural objective of the contest designer, in particular when efforts across stages are additively separable – see Sisak (2009) for an excellent survey of the literature addressing this criterion. Alternatively, complementarities between the efforts at different stages can imply that incentive maintenance across stages is the relevant criterion for the contest designer – the classical reference for this case is Rosen (1986) who argued that incentive maintenance is particularly important in corporate promotion contests.[2]

In this paper, we study the optimal design of a two-stage elimination contest with four homogeneous participants. Assuming that the overall prize money is fixed, we first show theoretically that a "winner-takes-all" structure with a single prize for the winner of the final round maximizes total effort under the standard assumption of common knowledge that all contestants are rational and risk-neutral. Then, we derive the prize structure that ensures incentive maintenance across stages under the same set of assumptions. As already shown by Rosen (1986), the optimal structure for the latter criterion turns out to be a format with two prizes, where the winner of the final receives most of the prize money, while a smaller part is assigned to the runner-up prize. Thus, the theoretical analysis based on risk neutrality suggests that there is a trade-off between the two optimality criteria 'maximization of aggregate efforts' and 'incentive maintenance across stages'. While we find that this trade-off does not depend on the number of stages or on the contest technology, the assumption that contestants are risk-neutral turns out to be crucial. In particular, under some simplifying assumptions (discussed in more detail in Section 2.3) we are able to show that the trade-off becomes weaker as the degree of (relative) risk aversion increases and might ultimately disappear for high degrees of risk aversion. We test these theoretical predictions using lab experiments. In particular, we implement two versions of the two-stage pairwise elimination contest that differ only in the structure of prizes: in the **single-prize** treatment (abbreviated as **SP**), we implement a "winner-takes-all" contest which allocates the entire prize money to the winner of the contest; this structure maximizes aggregate effort in the risk-neutral benchmark. In the **two-prizes** treatment (abbreviated as **TP**), the runner-up prize for the loser of the final is chosen such that incentives for effort exertion remain constant over both stages under risk neutrality. The experimental data reveal that effort choices by experimental subjects exceed their risk-neutral predictions substantially in both treatments. At the same time, the observed behavior is qualitatively in line with the theoretical predictions under risk neutrality: total effort is somewhat higher in **SP** than in **TP**, and incentives are maintained across stages in **TP**, but not in **SP**. The observed difference in total effort across treatments is smaller than predicted and statistically insignificant, however. To test whether risk attitudes account for the economically small and statistically insignificant difference across treatments in the total effort dimension, we disaggregate effort choices by risk attitudes of experimental subjects. We find strong evidence for the trade-off between total effort maximization and incentive maintenance for risk-neutral decision makers: for these subjects aggregate effort is significantly higher in **SP** than in **TP**, while only the **TP** treatment with a positive runner-up prize is capable to maintain incentives across stages. Moreover, the data suggest that the **TP** structure is better in both performance dimensions for strongly risk-averse subjects: incentives are only maintained in **TP**, and total effort is (weakly) higher in **TP** than in **SP**.

Our results matter for many contest schemes observed in reality. In sports competitions, for example, it is arguably not (only) the overall intensity across all playoff matches that matters for the interest of spectators (and therefore for the revenues a league is able to generate); it is also relevant how intensely players or teams fight in each game. For this application our results imply that a contest format with multiple prizes might well outperform a single-prize format in terms of overall intensity and in terms of maintaining intensity across plays if participants are sufficiently risk-averse. In the context of human resource management, our results suggest that a promotion contest might be able to kill two birds with one stone if employees are risk-averse. Since it is more likely to be the rule than the exception that employees are risk-averse, our results also provide a novel testable hypothesis for future empirical work. Both theoretical and experimental results suggests that firms who mainly care about total effort might want to choose an occupation-specific incentive profile for promotions. The optimal "steepness" of this profile is determined by the average risk-attitude of employees in a particular occupation, and there is convincing evidence that risk attitudes matter for sorting of employees into different occupations.[3]

Our results contribute to the recent experimental literature on optimal contest design. For a long time, the experimental literature focused on static contests.[4] In recent years, attention has shifted to dynamic settings and an increasing number of researchers now study dynamic contests with multiple stages. Our results are most closely related to Altmann et al. (2012) and Sheremeta (2010a), who both compare static (one-shot) and dynamic (two-stage) contests.[5] The paper by Altmann et al. (2012) considers a prize structure that predicts incentive maintenance across stages in the risk-neutral benchmark, and one of their main findings in the experiments is that effort provision in the first stage is much higher than in the second stage.

[2] Incentive maintenance is also an issue in sports tournaments where it is important to make all stages of the competition 'exciting' for the participants and observers.

[3] See, for instance, Bonin et al. (2007), Dohmen and Falk (2011), or Pollmann et al. (2012).

[4] Bull et al. (1987) is the seminal paper. See also Harbring and Irlenbusch (2003), Harbring and Lünser (2008) or Sheremeta (2011), as well as the references provided therein.

[5] Other related studies of dynamic contests are Parco et al. (2005), Amaldoss and Rapoport (2009), or Sheremeta (2010b).