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Uncertain contest success function

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ABSTRACT

In this article, contestants play with a certain probability in Contest A and with the complementary probability in Contest B. This situation is called *contest uncertainty*. In both contests, effort is additively distorted by a *contest noise* parameter which affects the sensitivity of the contest success function (CSF). In Contest A (B), this parameter is linearly added to (subtracted from) effort. We analyze the interaction of contest uncertainty and contest noise on contestant behavior and profit. For symmetric contestants, contest noise has an ambiguous effect on effort and profit. We show that more contest uncertainty can imply greater effort. Furthermore, an introduction of an infinitesimal degree of contest uncertainty can have a large impact on effort and profit. Based on the analysis, this article presents the contest organizer's incentive to manipulate the degree of uncertainty in the contest. For profit or effort maximization, the contest organizer should always eliminate any uncertainty. If contestants are asymmetric, more contest noise increases effort as well as competitive balance if both Contests A and B have the same probability of occurrence.

1. Introduction

Contests are characterized by agents eliciting (financial) effort to win a contest prize. Examples include patent races, political campaigns, lobbying, sports contests, and arms races in military conflicts. In the contest literature, it is usually assumed that contestants know exactly the characteristics of the contest in which they are involved. That means that the contestants have full information regarding the technology and structure of the contest success function (CSF) and they are able to anticipate their probability of winning the contest, subject to their opponents' behavior.

In this paper, we assume that two contestants are uncertain about which contest they are involved in. The contestants play with some probability of being in Contest A and with the complementary probability of being in Contest B. We denote this randomness as the *contest uncertainty*. In the model, the classical ratio form of the CSF is applied. In the CSF for both Contests A and B, a noise parameter is added linearly to the contestant effort where noise positively (negatively) affects effort in Contest A (B). Thus, the contestant effort is either strengthened or alleviated. We call this noise parameter *contest noise*. This paper analyzes the consequences of the contest uncertainty and noise on contestant behavior.

According to the previous argumentation, the competition between the two contestants is interpreted as follows: there are two different contests, A and B, and the contestants are unsure about which contest they are involved in. However, the setting can be interpreted alternatively: there is only one contest in which contestants are involved, namely a proportional-prize contest, but contest noise distorts the CSF of this contest.[2]

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[2] I am grateful to an anonymous referee who pointed out this interpretation. In a proportional-prize contest, the prize is shared by contestants in proportion to their investments (e.g., Long and Vousden, 1987). An experimental study of proportional-prize contests is provided by Cason et al. (2010); see also Dechenaux et al. (2012) for an extensive survey of the basic structures of contests and an excellent review of the corresponding experimental studies.

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This model can be applied in different situations. First, suppose that two athletes exercise with different levels of intensity for a competition. For the athletes it remains difficult to estimate how an additional hour of training will change their winning percentage in the competition. Second, two countries preparing for a war might be uncertain about the impact of additional military investment on their probability of winning in the conflict. Third, during their studies students may be uncertain about their future career choice and the impact of their investment in the job market. Depending on the particular sector and job area, they can be confronted with a highly professional human resources department. For instance, many well-respected consultancy and banking companies have sophisticated assessment centers trying to eliminate luck as much as possible from the application and selection process. On the other hand, an application to a smaller company or a start-up firm may be considered less professionally due to limited capacity, and therefore luck may be a more pronounced feature of the application and selection process.

In this article, we will show that contest uncertainty as well as contest noise is crucial for contestants' behavior. In particular, when Contest B is more likely, then the efforts are greater and profits are lower for symmetric contestants. Moreover, greater contest noise has an ambiguous effect on efforts and profits. Furthermore, more contest uncertainty can increase efforts and the introduction of an infinitesimal element of contest uncertainty can have a large impact on contestant behavior. For asymmetric contestants, greater contest noise increases efforts as well as competitive balance if Contests A and B have the same probability. In addition, this article considers the implications for a contest designer. The next subsection briefly summarizes the results from the related literature and highlights the differences with this paper's approach.

1.1. Related literature

Uncertainty has been introduced into the contest literature in different forms. In a seminal article, Lazear and Rosen (1981) analyze a rank-order tournament in which contestant effort is influenced by noise. They show that more noise leads to reduced efforts by risk-averse contestants.[3] Nalebuff and Stiglitz (1983) also consider a rank-order tournament. They analyze the optimal design of contests with imperfect information. In their model, noise only affects contestant behavior in the case of risk aversion.

One important branch of the contest literature focuses on uncertain contest prize valuations. The models used to explore this differ with respect to the information structure, the asymmetry and the distribution of the prize valuations, and the timing of contestant choice.[4] Hurley and Shogren (1998b) analyze a contest with asymmetric information. They show that a contestant without information about the prize valuation of his/her opponent reduces effort as the contest becomes more risky. The opponent increases (decreases) his/her effort accordingly if he/she is – ex ante – the underdog (favorite) in the contest.[5] Malueg and Yates (2004) consider a contest in which the players have private information concerning their valuation of the contest prize. However, the contestants' prize valuations can be correlated, and Malueg and Yates derive the critical conditions for which a Bayesian equilibrium exists. Wärneryd (2003) analyzes a two-player contest in which the contest prize is the same for both players but the specific value is uncertain. He shows that the expenditures are lower if only one player is uncertain about the prize, compared with a situation in which either both players are uncertain or neither of the two players is uncertain. Linster (1993) discusses the impact of uncertainty in a dynamic Stackelberg rent-seeking game in which the first player is unsure about the second player's type. Another interesting analysis is presented by Ludwig (2012), who provides a comparison of four contest settings. Contestant types can be privately or publicly observed and the game can be played simultaneously or sequentially.[6]

This article is also related to those by Baik and Shogren (1995) and Garakani and Gurtler (2011). Baik and Shogren (1995) analyze a contest in which the contestants are uncertain about their *relative* abilities.[7] Thus, the contestants know their own ability but they do not know about their opponents' ability. They find that uncertainty increases or decreases effort depending on how relative abilities influence the marginal effect of effort on the CSF. Furthermore, they analyze the contestants' incentive to elicit effort by spying on their opponents' to learn about their ability. Garakani and Gurtler (2011), on the other hand, analyze the incentives for an omniscient contest organizer to deliver information to the contestants regarding their opponents' ability.

The ratio form of the CSF is commonly applied in the contest literature. An interesting branch of the contest literature deals with the stochastic foundation of the ratio form. McFadden (1973) derives the logit form of the CSF on the basis of two assumptions: (i) effective effort depends linearly on individual effort and noise; and (ii) noise is distributed according to the extreme value distribution. Jia (2008) makes two different assumptions to obtain the ratio form of the CSF: (i) the contestants'

[3] Sheremeta et al. (2009) and Sheremeta et al. (2012) analyze effort noise within the framework by Tullock (1980). In contrast to Lazear and Rosen (1981), noise is multiplicatively introduced (instead of additively) into their model. They conclude from their model that more noise decreases effort.

[4] Nitzan (1994) presents alternative ways of modeling rent-seeking contests. He discusses risk aversion, uncertain prizes, and asymmetry in contests. Instead of incomplete information regarding the prize valuation, Fey (2008) and Ryvkin (2010) consider a contest in which players have private information regarding their effort costs.

[5] See also Hurley and Shogren (1998a).

[6] While the above-mentioned articles focus on an analysis of optimal behavior within a given uncertain environment, one could also ask: what is the optimal degree of risk? In a recent work, Kräkel (2008) discusses optimal contestant risk-taking behavior in asymmetric contests (see also Kräkel and Sliwka, 2004). He identifies two decisive effects for risk taking: (i) an *effort effect* (risk affects effort incentives), and (ii) a *likelihood effect* (risk affects the winning probabilities).

[7] Kräkel (2012) also considers a model in which the contestants have different abilities. In this paper, however, there is no allowance for uncertainty. The author shows that the contestant with the lowest ability can overcompensate for the weakness by eliciting greater effort.