Journal of Behavioral and Experimental Economics 59 (2015) 56–67

Contents lists available at ScienceDirect

Journal of Behavioral and Experimental Economics

journal homepage: www.elsevier.com/locate/socec

Which explanations for gender differences in competition are consistent with a simple theoretical model?

Christopher S. Cotton[a,*], Cheng Li[b], Frank McIntyre[c], Joseph P. Price[d]

[a] Department of Economics, Queen's University, Kingston, Ontario K7L 3N6, Canada
[b] Department of Finance and Economics, Mississippi State University, Mississippi State, MS 39762, USA
[c] Rutgers Business School, Newark, NJ 07102, USA
[d] Department of Economics, Brigham Young University, Provo, Utah 84602, USA

ARTICLE INFO

Article history:
Received 27 January 2015
Revised 10 September 2015
Accepted 13 September 2015
Available online 5 November 2015

JEL Classification:
D74
J16
J24
J78

Keywords:
Contests
Gender differences
Risk aversion
Competitive pressure
Overconfidence

ABSTRACT

Recent studies show that males may increase their performance by more than females in response to competitive incentives. The literature suggests that this may contribute to observed gender gaps in labor force pay and achievement. Understanding which factors may drive these gender differences is essential for designing policies that promote equality. We adopt a game theoretic model of contests to consider a variety of explanations for the differences in male and female competitive performance that have been proposed in the empirical and experimental literature. Comparing the testable predictions of the model with the empirical evidence from past papers, we reject explanations involving male over-confidence, misperceptions about relative ability, and some types of preference differences. Explanations involving female under-confidence and differences in risk aversion are consistent with the significant evidence. Two explanations provide perfect matches to observed performance patterns: (i) males are better than females at handling competitive pressure, and (ii) males enjoy competition more or have greater desire to win than females.

1. Introduction

A number of recent articles show that males and females respond to competitive incentives differently. Gneezy et al. (2003) conduct experiments in which college students solve mazes, either on their own or in a contest with other students. They show that competition causes males to increase their performance by more than females. Gneezy and Rustichini (2004) find similar results in footraces between young children: males increase their performance in the face of competition, while females do not. Cotton et al. (2013) conduct multiple-round math competitions and find evidence that males outperform females of *similar* ability during the initial round of competition.[1] This male advantage may help explain achievement differences between males and females that have been documented in competitive academic and workplace settings (Blau and Kahn, 2000). Understanding which factors may be driving these gender differences is therefore essential for designing policies to promote equality.

The experimental and empirical literature suggest that a variety of factors could drive the observed male performance advantage. Possibilities involve real or perceived differences in confidence, ability, or risk aversion (see Gneezy et al., 2003; Niederle and Vesterlund, 2007; 2011; Gneezy and Rustichini, 2004; Croson and Gneezy, 2009; Günther et al., 2010). These articles tend not to provide a game theoretic framework to assess the merits of the explanations.[2] However, there exists an extensive theoretical literature modeling contests and tournaments that can provide insight into the causes of the observed

* Corresponding author. Tel.: +16135332251.
E-mail addresses: cotton@econ.queensu.ca (C. S. Cotton), cheng.li@msstate.edu (C. Li), frank.mcintyre@business.rutgers.edu (F. McIntyre), joe_price@byu.edu (J. P. Price).

[1] Some recent articles work to determine in which settings the male advantage exists. Cotton et al. (2013) show that the male advantage only lasts for one round in such a setting, and depends crucially on the framing of the competition as a race. Günther et al. (2010) find that the male advantage is task dependent, as they show that it exists during maze competitions, but not during competitions involving word games, pattern matching, or memory tasks. Gneezy et al. (2009) present evidence that gender differences in the face of competition depend on participant background and social norms. Our analysis is only applicable to settings where the male advantage does exist.

[2] There does exist a complementary literature on bidding behavior in auctions and contest experiments that do not involve real effort (e.g. Casari et al., 2007; Ham and Kagel, 2006; Sheremeta, 2013; Chen et al., forthcoming). This literature often does consider a theoretical foundation. We discuss this literature in the context of our analysis at the conclusion of our paper.

http://dx.doi.org/10.1016/j.socec.2015.09.005
2214-8043/

gender differences. By comparing theoretical predictions with the empirical observations, we learn which of the proposed explanations for the observed gender differences are consistent with the theoretical predictions.[3]

The current article presents a simple model of competition adapted from the game theoretic literature on contests. In the model, agents simultaneously choose effort, where their performance in the contest is a function of both effort and ability, with the probability of winning the contest increasing in one's own performance and decreasing in one's opponent's performance. Players may differ in their ability or preference parameters, as well as in their (potentially inaccurate) beliefs about ability. The model, based on Tullock (1980) and Baik (1994), is the standard framework in the theoretical literature for modeling contests between asymmetric players.[4] We adapt the model to consider various explanations of the male advantage, allowing male competitors to differ from female competitors in terms of their preferences, confidence and ability; in an extension we consider differences in risk aversion. In order to isolate the effects from each individual explanation, we consider each possible explanation separately. For example, when considering explanations involving ability differences, the model incorporates differences in ability while holding differences in preferences and confidence fixed. When considering explanations involving differences in risk aversion, the model considers a game in which males and females differ only in their risk aversion. To further simplify the analysis, we also assume that the two groups are homogeneous, abstracting from within-gender differences among males or females. The result is a relatively simple framework that allows for the straightforward comparison of different explanations for the male-performance advantage that exists in certain environments; it is not a general theory of gender differences in competition.

In equilibrium of our games, a competitor's effort and performance depends on his or her own type, as well the type of his or her opponent. The analysis is therefore concerned about the relative performance of four player types—males in single-gender competition (*MvM*), males in mix-gender competition of half females and half males (*MvF*), females in mix-gender competition of half females and half males (*FvM*), and females in single-gender competition of females only (*FvF*)—and whether the predicted performance differences between these four groups match the patterns observed in the data. We solve cases with two competitors and six competitors separately, showing how the number of competitors affects the predicted performance patterns in certain settings.

We compare the theoretical predictions of the model with the empirical evidence from Gneezy et al. (2003) (which involved six competitor experiments) and Cotton et al. (2013) (which involved head to head contests between two competitors). We chose these papers due to data availability, because Gneezy et al. (2003) is the seminal paper on the topic, and because Cotton et al. (2013) involved an experiment involving head-to-head contests that closely resemble the underlying theoretical model with two players. The data allow us to draw conclusions about the relative performance of the four player types: *MvM*, *MvF*, *FvM*, and *FvF*. We review the data in detail in Section 2. In that section, we describe the criterion that we use to determine how well alternative theoretical explanations match the data.

The theoretical model predicts behavior that, while well known among contest theorists, may go against popular intuition. For example, the model shows that competitors put in the most effort in contests in which they are evenly matched against a single opponent. Starting from an evenly-matched contest, *increasing* one player's ability results in a less competitive contest, and in equilibrium both players respond by expending *less* effort. The high-ability player puts forth less effort because he can do so less effort and still perform better than before. The low-ability player puts forth less effort because her marginal expected return from effort is decreasing in opponent ability. This means that in a lopsided contest, both players put forth less effort than in a contest between two same-ability players. A high-ability competitor is more likely to win a contest against a low-ability competitor, not because he puts in more effort than his opponent, but rather because he achieves higher performance with equal effort. This is an important distinction when considering explanations in which players have misperceptions about their own ability or the ability of their opponent. If, for example, a player is over-confident in his own ability, then he underestimates the competitiveness of the contest, and puts in less effort than if he had accurate beliefs about his ability. If his ability advantage was real, his lower effort would not fully offset the advantage of higher ability, and he would still experience an increase in performance. However, because he overestimates his ability, his lower effort results in lower equilibrium performance.

The case of overconfidence illustrates the importance of formally considering the theoretical model. Gneezy et al. (2003) hypothesize that "It might be that men are solving 'too many' mazes, because they … are over-confident about their abilities and hence their chances of actually winning the tournament" (p. 1060). This statement and others found in the literature are inconsistent with a game theoretic model of contests. If a male overestimates his ability, he underestimates the competitiveness of the contest which causes him to put in less effort and perform worse than opponents who have correct beliefs about ability. The theoretical analysis shows that overconfidence has the opposite effect on performance than what has been assumed in the literature, and by comparing the model to the empirical requirement, we are able to reject the male-overconfidence explanation of gender differences. For similar reasons we can also reject a model in which players have incorrect beliefs about male or female ability. Additionally, we rule out other explanations for the male advantage including explanations in which players dislike losing to females. This leads us to reject explanations for the male advantage involving male-overconfidence or general misperceptions about ability, as well as a number of explanations involving preference differences.

We find that other explanations for the male performance advantage are more consistent with the theory, to differing degrees. When females are under-confident in their own abilities or more risk-averse, they tend to underperform compared to males. While this outcome is consistent with the most significant empirical evidence, it does not predict the exact same effect of opponent gender on performance as observed in the data. Because of this, we view the female under-confidence and higher female risk aversion models as feasible but moderately less-likely explanations of the performance patterns compared to models which perfectly predict the performance differences observed in the data.[5]

Two explanations are perfectly aligned with the empirical patterns. First, males may be better at dealing with competitive pressures. This explanation does not imply that males are inherently better at solving math questions, completing mazes, or running races.[6]

[3] There has been a growing recognition that theory can complement experimental design. See for example, Yariv (2015) who considers how the combination of experimental and theoretical economics has evolved over time, and other papers in Part 2 of Fréchette and Schotter (2015).

[4] See also Dixit (1987); Nitzan (1994); Stein (2002), and Brown (2011). Skaperdas and Gan (1995) incorporates differences in risk aversion into such contests. Applications of contest theory to workplace achievement include O'Keeffe et al. (1984); Main et al. (1993); Chan (1996); Tsoulouhas et al. (2007) and Carpenter et al. (2010).

[5] Although there is substantial empirical evidence that "women are indeed more risk averse than men" (Croson and Gneezy, 2009, p. 448) in a variety of settings, we are the first to illustrate how risk aversion alone may result in the within competition performance differences between males and females. Dohmen and Falk (2011) empirically show that females are no less likely to sort into competition than males when controlling for differences in risk aversion. However, their analysis focuses on selection into contests, rather than performance in competition.

[6] Cotton et al. (2013) and Gneezy and Rustichini (2004) find gender differences even when controlling for a student's performance in a non-competitive setting.