15. Do men and women respond differently to economic contests? The case of men's and ladies' figure skating

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15.1 INTRODUCTION

A consensus has developed in the economics literature that economic contests can elicit efficient levels of effort from the participants. This occurs in both the corporate world (for example, Bognanno, 2001) and the realm of sports. Economic contests base rewards on a participant's rank rather than marginal product. As a result, small improvements in productivity bring discrete changes in rewards if they change a participant's rank, while large improvements bring no change in reward if the participant's rank is unchanged.

Because of the detailed data on performance and compensation that exist for professional athletes, sports provide a particularly appropriate setting to analyze the incentive effects of economic contests, which are also known as rank order tournaments (ROT). A broad literature now applies ROT theory to a variety of sports. At first, almost all applications of ROT theory to sports—like the sports economics literature in general—pertained solely to men's sports. Increasingly, however, sports data are used to test the hypothesis that women and girls are more hesitant to join a rank-order event and that they perform worse in competitive environments than men and boys. Numerous papers using experimental data have supported this hypothesis. If these experimental findings can be confirmed using 'real-world' data, then reward structures based on economic contests could place women at a distinct disadvantage to men in the labor market.

This chapter compares the impact of a particular economic contest on the performance of male and female figure skaters. Using data from the 2009–10 figure skating season, we test three hypotheses that have been raised by the experimental literature regarding the behavior of men and women. First, we ask whether men and women respond differently to the incentives provided by the competition. Second, we test whether women respond more negatively than men to disappointing performance in the early rounds of the competition. Finally, we test whether women avoid competition more than men do.

Our results largely contradict the experimental literature. We find that women respond more positively than men to the incentives posed by the economic contest presented by figure skating competitions. Similarly, female figure skaters are more resilient in the face of negative feedback than their male counterparts, and they do not avoid competing with other elite skaters. These results suggest that the findings of the experimental literature do not apply to elite female figure skaters. Further research is therefore needed before one can conclude that female executives, who, like figure skaters, have self-selected into a given occupation, are at a disadvantage in competitive settings.

Section 15.2 provides background on the theory of economic contests with specific application to sporting events. Section 15.3 explores the literature regarding differences in how men and women respond to economic contests. Section 15.4 shows how figure skating can be modeled as an economic contest. It also presents the estimating equation and describes our data set. Section 15.5 contains the estimation results, and Section 15.6 concludes.

15.2 ECONOMIC CONTESTS

The literature on economic contests begins with the seminal paper by Lazear and Rosen (1981). Lazear and Rosen note that analyses of labor markets typically assume that workers are paid their marginal revenue product, the value of their effort. A system of compensation that ties workers' pay directly to their contributions to firm revenues, often called 'piece rate', generates the efficient level of effort by workers, who exert effort until the compensation for a little more effort (producing one more piece) equals the marginal disutility of effort. The piece-rate system, however, works only if employers can observe the marginal physical product (MPP) of their employees. Unfortunately, such close monitoring of workers is either impossible or prohibitively costly for any but the simplest tasks. Thus, while it might be easy for employers to pay a piece rate if their workers sell cars or pick fruit, a piece-rate system becomes far less practical when the workers produce a less tangible, less easily counted good or service. As a result, according to Lazear and Rosen, many firms reward slightly more productive workers with wages and salaries that are much higher than the pay of their less productive coworkers, even if the absolute differences in productivity are small.

Lazear and Rosen develop a two-period model in which employers wish to elicit the optimal amount of effort from two identical employees.¹ In the first period, the employer specifies a reward structure, with the more

productive employee receiving a high wage (w_1) and the less productive employee receiving a low wage (w_2). The two wages are set so that the expected profits of the firm (assumed to operate in a competitive market) are zero. In the second period, the workers effectively compete for the high wage, with the more productive employee being declared the winner. Under a set of relatively general conditions, Lazear and Rosen show that setting the appropriate spread between w_1 and w_2 elicits the efficient amount of effort by both workers. The ROT thus bases workers' rewards on their productivity relative to other workers, rather than on the absolute level of their productivity. The winner of the tournament receives a reward that exceeds his/her MRP, while the loser receives a reward that is lower than his/her MRP. The firm can elicit more effort from its workers by increasing the difference in rewards or less effort by reducing the difference in rewards. An appropriately designed ROT can reproduce the results of a piece-rate system without the costly monitoring needed for a piece-rate system.

In separate papers, Lazear and Rosen modify their basic model. Lazear (1989) notes that workplace relations can affect workers' responses to pay disparities. In particular, activities that require workers to cooperate ('team-work') might suffer when workers focus on their individual contributions. Worse still, workers might attempt to undermine the performance of their coworkers. Rosen (1986) extends the original model to the multi-period setting of an elimination tournament. In an elimination tournament, losers at stage s of a tournament receive compensation $w_{s,s}$, while winners at stage s get the right to compete at stage $s + 1$, where the loser receives $w_{s+1} > w_s$. Rosen shows that the more talented participants do not exert maximal effort unless the ultimate prize is disproportionately large. Thus, as the reward for winning the tournament, w_N , rises, the chance of an upset in the tournament falls, as the more talented performers exert increasing effort.

O'Keeffe et al. (1984) extend the model by accounting for global, rather than marginal, incentives. In particular, they analyze incentives when the contest involves such unequally talented contestants that a marginal increase in effort has no impact on rank outcome. They conclude that individuals who have little chance of winning the contest maximize their utility exerting the minimum possible amount of effort required to stay in the tournament.

Ehrenberg and Bognanno (1990a and 1990b) were the first to view sports competitions as economic contests, forming the basis for the ensuing literature. They make two key observations regarding tournaments in the US and European Professional Golf Association (PGA) Tours. First, the percentage of the purse awarded to each participant follows a fixed, predetermined distribution across all tournaments. This fixed distribution of prize money awards much more of the purse to the first-place finisher than to the

second-place finisher (18 versus 10 percent), and the differential falls until the reward for moving up one spot approaches zero. For example, the incentive to move from second to first place is much greater than the incentive to move from 22nd place to 21st place. Second, the size of the purse differs across tournaments so that the absolute size of the reward differential varies across tournaments even if the percentage of the purse is constant.

Ehrenberg and Bognanno (1990a and 1990b) use the above observations to formulate two hypotheses. First, they posit that golfers who enter the fourth (final) round of a tournament higher up the leader board have a greater incentive to play well than players who are farther down because the reward to improving their position is much greater. Therefore, scores for leading golfers will be better than for those who are farther behind, all else equal. Second, because larger purses lead to larger rewards to moving up the leader board, players have a greater incentive to play well in tournaments in which the total prize is greater. Thus, scores will be lower in tournaments with greater prizes, all else equal.

Ehrenberg and Bognanno test the above hypotheses by estimating the equation:

$$s_{ji} = \alpha_0 + \alpha_1 TPRIZE_i + \alpha_2 \mathbf{x}_i + \alpha_3 \mathbf{y}_j + \alpha_4 \mathbf{z}_i + v_{ij} \quad (15.1)$$

The explanatory variables in equation (15.1) consist of the total amount of prize money awarded in tournament i ($TPRIZE_i$) and three vectors: the first vector contains variables related to the difficulty of the course in tournament i ($\mathbf{x}_i$), the second contains variables related to the ability of golfer j ($\mathbf{y}_j$), and the third contains variables related to the ability of the other golfers in tournament i ($\mathbf{z}_i$). Equation (15.1) remains the basis for current empirical research on the impact of tournament settings.

Ehrenberg and Bognanno specify the dependent variable (s_{ji}) in three different ways. To test for the impact of the prize differential on a player's overall performance, they define the dependent variable as the total number of strokes by player j in tournament i . To test whether the differential affects all rounds of the tournament equally, they also run two separate regressions. In the first, they define s_{ji} as the number of strokes in the first two rounds ('before the cut'). In the second, they define s_{ji} as the number of strokes in the final round.

Ehrenberg and Bognanno (1990a and 1990b) obtain similar results for the US and European professional golf tours. They find that the size of the purse reduces the overall number of strokes, indicating that larger prize differentials elicit better performances. However, they find no impact on the score in the first two rounds, which suggests that the distribution and size of prize money does not affect performance when the impact of effort

is still unclear. This is confirmed in the final specification. In this estimation, Ehrenberg and Bognanno use the ranking of the player headed into the final round as well as the total size of the purse to find the monetary impact of an improvement in ranking. They find that these incentives have a strong impact on golfers' scores in the final round. The link between the reward to improved standing and performance remains at the heart of empirical analyses of tournament settings.

In their study of professional road racing, Lynch and Zax (2000) explicitly consider the role of the purse on the field of competitors. When they do not control for the underlying ability of the participants, Lynch and Zax find that larger purses lead to superior performances. When they control for underlying ability, their results show that the faster times result from the fact that larger purses attract better runners. The superior performance could thus result from self-selection by potential participants rather than stronger incentives for those who do participate.

Gilsdorf and Sukhatme (2008a and 2008b) test Rosen's theory of elimination tournaments in women's and men's professional tennis. They find evidence supporting Rosen's (1986) theory that greater mismatches result in lower effort for both men and women. They also find that larger purses, and hence larger monetary differences in prize money for the winner and loser, increase the probability that the favored player wins at each stage of the tournament.

Frick et al. (2003) test Lazear's hypothesis that teamwork limits the power of pay differentials to stimulate performance. They specify team performance for the four major North American sports leagues (Major League Baseball: MLB; the National Baseball Association: NBA; the National Football League: NFL; and the National Hockey League: NHL) and find that salary differentials among teammates, as measured by the Gini coefficient, have an uneven impact on team performance. In particular, they find that pay spreads have a positive impact on performance in the NBA, a statistically insignificant impact in the NFL and NHL, and a negative impact in MLB.

15.3 GENDER DIFFERENCES IN THE RESPONSE TO ECONOMIC CONTESTS AND COMPETITIVENESS IN SPORTS

15.3.1 Economic Contests

There is now a large literature detailing the different ways in which men and women respond to economic contests. The broad conclusions of this

literature (excellently summarized by Croson and Gneezy, 2009) are that women do not respond as well as men when the reward is determined competitively, with the winner taking a disproportionate reward. Consistent with this finding, women are more reluctant than men to enter such competitions. Such aversion to competition could put women at a disadvantage in the corporate world and in other settings where rewards are set by competition among workers. Much of this literature, however, is based on experiments, whose results are often contradicted by studies using non-experimental data.

In one of the first tests of gender differences in contests, Gneezy et al. (2003) conducted a controlled experiment in which students at the Technion, an engineering university in Israel, were asked to solve mazes. Some of the students were told that they would be rewarded based on the number of mazes they solved in a given time period (a piece-rate scheme), while others were told that the person who solved the most mazes in their group would receive the prize. They found no difference, on average, in the number of mazes men and women solved in the piece-rate setting. However, when faced with a competitive setting, men's performance improved but women's performance was unchanged, resulting in a gender gap. They found that the gap was greatest in mixed-gender groups.

Gneezy and Rustichini's (2004) results largely support the earlier findings. They had Israeli fourth graders run in timed, individual settings and then in head-to-head competitions. They found that girls ran more slowly in the head-to-head competition than in the non-competitive settings, while boys ran faster. Their results were independent of the gender composition of the race (same-sex or mixed) or the relative abilities of the competitors, as measured by their results in the non-competitive race.

Booth and Nolen (2012) note one potential consequence of the gender difference in performance. They randomly sorted a sample of English high-school students into single-sex and mixed groups and then, like Gneezy et al. (2003), had the students solve mazes under piece rates in one round and in tournament settings in another round. In the third round, they allowed the students to choose either a piece rate or tournament reward system. They found that girls were more likely than boys to choose the piece-rate setting, though the gap was smaller for girls who attended single-sex high schools.

Gill and Prowse (2010) provide an important insight into why women perform relatively poorly in economic contests and seek to avoid them more than men. In their experiment, men and women were randomly assigned to groups of two, though the identity of the partner was kept secret. All participants were asked to position a 'slider' on a computer screen using a mouse. They were scored based on how many sliders they

were able to place at exactly 50 on a scale of 0 to 100 in two minutes. The prize for the round was then awarded to a single winner, based on a lottery. The likelihood of winning the lottery rose with the participant's performance of the task.² Performance was thus not the sole determinant of whether a person won the prize, as the luck of the draw also played a significant role in determining the winner. Gill and Prowse find that women respond to not winning as a result of bad luck by reducing their effort in later rounds of the experiment. The gender difference in the response to bad luck is so pronounced that the 'differential responses to luck account for about half of the gender performance gap that we observe in our experiment' (p. 1).

15.3.2 Competitiveness

There is a small but growing literature concerning gender differences in the response to competitive settings in sports. The evidence of these studies is decidedly mixed. Some studies find differences in behavior of men and women, but the stark contrast of the experimental studies is generally not supported. This contradiction between experimental and non-experimental settings might reflect the fact that labor markets do not have random assignments of workers. Instead, individuals – ranging from professional athletes to corporate executives – self-select into specific occupations, which could result in behavior that differs from that in a laboratory setting.

Matthews et al. (2007) apply Ehrenberg and Bognanno's (1990a and 1990b) model to women's golf on the LPGA Tour. They find evidence that women respond negatively to incentives by shooting higher scores in tournaments that offer higher purses.³ There are, however, two weaknesses with this argument. First, the evidence of a perverse effect is not strong, as the key coefficients are frequently statistically insignificant. Second, the results might be affected by selection bias because Matthews et al. include only golfers who were among the top 50 money winners in 2000.

Gilsdorf and Sukhatme (2008a and 2008b) find little difference in the behavior of male and female tennis players. Using probit estimation, they show that purse size is positively related to the likelihood that higher-seeded players win in both men's and women's tennis tournaments, as predicted by Rosen (1986). Because each match in an elimination tournament must have a winner and a loser, Gilsdorf and Sukhatme's results are necessarily measures of relative outcomes. By construction, the study cannot address whether the overall quality of play increases or decreases with the size of the purse or how this change compares with the quality of play in men's competition.

Paserman (2010) also finds no support for gender differences in competitive situations. He uses stroke-by-stroke data from seven Grand Slam tennis tournaments to analyze how men and women respond to pressure situations. He finds that both men and women play more cautiously and hence make fewer unforced errors at key points in the match. The drop in unforced errors by men and women is statistically indistinguishable.

Unlike the other studies in sports, Frick (2011) addresses gender differences in participation decisions rather than in performance. His results support Booth and Nolen's (2012) hypothesis that women avoid competitive situations. To do this, he matches the finishing times for the top 200 male and female runners at each distance from 3,000m to the marathon, using data from 1973 through 2009. Frick computes the percentage difference in times by the man and woman at each rank and finds that the percentage difference between men's and women's times grows as the numerical rank rises (meaning the rank worsens). He concludes from this finding that the field of women runners was less balanced than the men's field, in that poorly ranked men are closer to the top-ranked men than is the case for women. Because men and women have the same number of lucrative races, Frick concludes that the top female athletes were able to avoid competing against each other by strategically entering certain events. He finds, however, that this avoidance has declined over time.

15.4 FIGURE SKATING AS AN ECONOMIC CONTEST

We have shown above that the experimental literature and the non-experimental studies that use sports competitions frequently yield contradictory results. One reason for this inconsistency is the failure of the non-experimental literature to screen out factors that could confound the results of the contest. Figure skating competitions provide a more perfect 'laboratory' because they avoid two important pitfalls that confront most previous studies of sports contests.

First, many previous studies of economic contests in sports involve head-to-head competition. In some cases, as in tennis, the studies look only at relative performance. They therefore cannot say whether the outcome results from one player's elevating her game or the other player's falling back.⁴ Even unforced errors, as measured by Paserman (2010), could be a response to an opponent who is dominating the match or simply playing unexpectedly well. The same could be true in competitions that are not explicitly confrontational, such as racing or golf. In these

supposedly individual sports, one performs simultaneously with one or more opponents, so one's performance could be a direct response to what they do. A runner, for example, could respond to an unusually fast or slow pace set by her competitors, or a golfer could attempt a particularly risky shot after seeing a golfer in her group make a spectacular shot.

In figure skating, the competitors perform sequentially, and, as a result, cannot be affected by the skaters who come after them. The impact of earlier skaters is only indirect, as skaters perform routines that are generally known in advance and offer little room for spontaneity. Thus, skaters can react only to the knowledge that the earlier skaters have performed particularly well or particularly poorly. Hence, one skater's performance is less likely to have a direct impact on the performance of another skater than is the case in most other athletic competitions. In addition, we have access to the scores of all skaters, so we can measure the absolute level of performance of each woman, not just her relative performance.

Second, the other sports are exposed to the elements. Studies of performance must therefore take account of such outside forces as the weather or the difficulty of a course. Even the most comprehensive of datasets cannot fully account for all such factors, as they can change from one moment to the next. The best one can do is hope that the omitted variables have a random effect on performance. In contrast, figure skating competitions take place on a uniform surface over a fixed period of time. There is therefore little chance that outside factors beyond the competitors' control will affect the quality of the performance.

Figure skating also enables us to look beyond how men and women respond to tournament conditions and test how men and women respond to positive or negative feedback. Because the competition takes place in two stages, skaters enter the Free Skate knowing how they had been judged in the Short Program. (The segments of figure skating competition are described in detail below.) They skate in groups of six, with the six skaters with the worst Short Program scores skating first and the six skaters with the best Short Program scores skating last. The order within each group of six is determined by a random draw. The results of the Free Skate (also known as the 'Long Program') allow us to test whether men women and men respond to relatively poor performances by reducing their effort, as suggested by Booth and Nolen (2012) and by Gill and Prowse (2010).

Finally, we can test whether Frick's (2011) claim – that elite women avoid head-to-head competition with one another while men do not – extends to figure skating. Our data from the 2009–10 figure skating season allow us to identify the participants in each of the competitions. We can combine these data with skaters' points from the previous season to test

whether the women's field in any given competition is more or less homogeneous than the field in the men's side of the same competition.

15.4.1 Figure Skating as an Economic Contest

Like the golf tournaments studied by Ehrenberg and Bognanno (1990a and 1990b), figure skating competitions involve multiple rounds. Skaters typically participate in two rounds, each of which is evaluated by a panel of judges.⁵ As in golf, a skater's rank is determined by the sum of the two scores. Unlike golfers, figure skaters win by receiving the highest (as opposed to the lowest) score. In addition, while golf consists of playing the same set of 18 holes four times, a skating competition consists of two very different stages.

The first portion of a skating competition is known as the 'Short Program'. The Men's and Ladies Short Programs both last two minutes and fifty seconds, with a penalty assessed against skaters who exceed their allotted times. In 2009–10, the Ladies' Short Program contained eight required elements, consisting of three types of jumps, three types of spins, a step sequence, and a spiral sequence.⁶ The Men's Short Program also required three jumps and spins, but the spiral sequence was replaced with another step sequences. For a detailed listing of the elements, see Appendix 15A1. Skaters perform the Short Program in random order and are then divided into groups of six based on their scores. The group with the lowest (worst) six scores performs the Free Skate first. Subsequent groups contain better-ranked skaters until the group with the highest (best) six scores skates last. (There is a maximum of four groups.) The order within each group of six in the Free Skate is randomly determined.

As its name suggests, the Free Skate gives competitors more freedom over the individual components of their performances than the Short Program does. The Ladies' Free Skate lasts four minutes and must contain seven jump elements, three combinations, three spins, one step sequence, and one spiral sequence. The Men's Free Skate lasts a half-minute longer. The men may perform up to eight jump elements, three spins, three combinations, and two step sequences. For a detailed explanation of how judges score skating routines, see Appendix 15A2.

The reward structure in figure skating is based on a skater's final standing rather than on the total number of points she is awarded. We include several different types of figure skating competitions. The 2010 Olympics and the 2010 World Championship are by far the two most prestigious events in our sample. Although neither competition carries an explicit monetary award, a skater's fame and chances for outside income typically depend on finishing 'on the podium', among the top three skaters.⁷

The European Championship is not on the same level as the World Championship, but it is a major international competition that assembles many of the world's top figure skaters. The European Championship was prestigious enough that the International Skating Union (ISU) – the body that oversees figure skating, synchronized skating, speed skating, and short-track speed skating – created the Four Continents Championship for skaters from Africa, the Americas, Asia, and the Americas in 1999 to serve as an equivalent competition. Finally, we include the ISU Grand Prix events. The skaters with the top cumulative scores in the season's Grand Prix competitions meet in the ISU Grand Prix Final. In Grand Prix events themselves, monetary prizes depend on the skaters' order of finish rather than on the number of points she accumulated.

15.4.2 Estimation and Data

Our estimating equation closely resembles that of Ehrenberg and Bognanno (1990a and 1990b):

$$s_{ij} = \beta_0 + \beta_1 \mathbf{x}_i + \beta_2 \mathbf{y}_j + \beta_3 \mathbf{z}_{ij} + \varepsilon_{ij} \quad (15.2)$$

In Equation (15.2), s_{ij} is the Free Skate score by skater i in competition j , $\mathbf{x}_i$ is a vector of variables pertaining to the ability of skater i , $\mathbf{y}_j$ is a vector of variables describing competition j , and $\mathbf{z}_{ij}$ is a vector of variables reflecting the performance of skater i in the Short Program of competition j . (Because prize money is not always awarded, we have left out the prize variable.) The vector $\mathbf{x}_i$ contains variables relating the skater's age and the number of points he/she accumulated in 2008–09 competitions. We have no clear prediction as to the impact of a skater's age, but we do expect a higher score in 2008–09 to imply that a skater is more inherently talented and will perform better in 2009–10 competitions.

Unlike Ehrenberg and Bognanno, we do not have to account for many external factors that would affect an athlete's performance, such as differences in course size or weather conditions, as each skating competition takes place under uniform physical conditions. However, there are a number of competition-specific factors that could affect the final score. First, it is possible that the judging in some competitions is harsher than the judging in others. To capture the fact that all scores might be higher or lower in some competitions, the vector $\mathbf{y}_j$ contains the mean score of all skaters in the competition's Short Program and whether the competition took place in the skater's home country. In addition, while the Olympics and the World Championships do not have a monetary prize structure, they are better known than the other competitions, and success in them is

likely to have a greater impact on a skater's lifetime income than success in any other competition. We therefore include dummy variables that indicate whether the competition was the Olympics or the World Championship.

The average level of judging in the Short Program could reflect easier judging overall or could lead judges to 'make up' for the high scores by judging the Free Skate more harshly. We have no clear prediction regarding its effect. We do expect a 'home ice' advantage thanks to less travel and a more supportive audience. In addition, studies of basketball have shown that home fans affect the judgment of referees (Moskowitz and Wertheim, 2011). While such an impact would add to the home ice advantage, the judging system described above was instituted in part to minimize subjectivity in judging, thereby reducing the impact of a home crowd on judges. The total score is determined by a randomly selected subset of the judges marking the event.

If figure skating competitions had the same incentive effects as the golf tournaments analyzed by Ehrenberg and Bognanno (1990a and 1990b), a skater's performance should be better in the more highly valued events, even after controlling for the quality of the competitors. We therefore expect the dummy variables for the Olympics and World Championships to have a positive effect on Free Skate scores.

Finally, we include a set of variables that capture the individual skater's performance going into the Free Skate. These variables consist of the skater's score in the Short Program, the skater's rank after the Short Program, the number of points by which the skater trails the leading skater after the Short Program, and whether the skater is among the best six skaters entering the Free Skate and thus skates in the last group.

A performance in the Short Program that places a skater closer to the leader increases the likelihood that the skater could win the competition – or at least end up on the podium with a good performance in the Free Skate. We expect all measures of individual performance in the Short Program to be directly related to the skater's score in the Free Skate.

Unfortunately, these variables do not capture only incentive effects. Even the best of skaters can have a subpar competition, and sometimes a lesser skater can have the competition of a lifetime to upset otherwise more accomplished skaters. A positive coefficient on the variables related to a skater's score in the Short Program could reflect either the response to incentives or the continuation of a positive or negative 'shock' in that competition.

One variable, however, explicitly captures the incentive effect. In addition to the absolute performance as measured by the Short Program score and the relative position given by the placement entering the Free Skate, we have a dummy variable that indicates whether the skater was in the

final group of skaters for the Free Skate. As noted above, the group in which skaters perform their Free Skate is determined by their performance in the Short Program. A skater's appearing in the final group provides no new information on skill or incentives once one controls for the variables described above. However, skating in the final six, with the top skaters in the competition, changes the 'atmospherics' surrounding the skater. If, as hypothesized by Booth and Nolen (2012) and Gill and Prowse (2010), women respond more negatively to disappointment than men do, then skating in the final six should have a stronger impact on women than on men.

In a second regression we add an interaction term that equals the product of the skater's point total in 2008–09 and a dummy variable that equals one if the competition was the Olympics or the World Championship. We include this variable to determine whether more talented skaters perform better in the more prestigious competitions. This test is analogous to that performed by Gilsdorf and Sukhatme (2008a and 2008b) when they test whether favored tennis players are more likely to win a match when the match has a greater monetary reward.

We collected data for competition results of seven ISU 'Grand Prix' events plus four championship events: the European and Four Continents Championships, the 2010 Olympics, and the 2010 World Championships (ISU 2009a–g, 2010a–c).⁸ The websites for these events provided detailed information on the skaters' performances as well as their ages and home countries. We obtained data on the skater's performance in the 2008–09 season from figure skating world rankings (ISU 2011). The ISU calculates this performance measure by adding the skaters' scores in the Olympics and/or World Championships and their top and second-best scores in Grand Prix and other international competitions. We used the total points for the 2008–09 season as a measure of a skater's ability entering the 2009–10 season. Evgeny Plushenko presented something of a problem, as he did not skate competitively during the 2008–09 season but was a dominant skater in the following season. Rather than delete him from the sample, we gave him a score that was equal to the highest men's point total in 2008–09.

The means for the variables appear in Table 15.1. Men were, on average, about a year and a half older than women. Men's scores in the Free Skate were about 32.5 points higher, in part reflecting the greater length of the program and the greater number of permitted jumps. Partly because the Short Program is the same length and because the routines are more precisely delineated, the difference between the mean scores of men and women was only 6.5 points. Average total points in 2008–09 were lower for men, probably because we had data for more men, which means that

Table 15.1 Means of key variables

Variable	Men	Women
Age of Competitor	22.14	20.41
Score in the Short Program	69.10	54.11
Rank after Short Program	9.07	9.03
Mean Score of Short Program	60.32	53.88
Skated on Home Ice (% of total)	0.14	0.14
In Last Group of Skaters (% of total)	0.40	0.42
Olympic Competition (% of total)	0.14	0.16
World Championship (% of total)	0.14	0.16
Points in 2008–2009	545.50	690.07
Points Behind Top Skater	16.48	13.62
Score in Free Skate	128.25	95.65

our men's sample had more marginal skaters. The only other difference of note was that, on average, men trailed the leading skater by almost three points more than the average woman did in 2009–10, though this could be due to the larger sample of men.

15.5 RESULTS

Before running regressions to analyze skaters' responses to tournament settings, we checked the data to see whether elite female figure skaters avoided head-to-head competition, as Frick (2012) claims is the case for elite female distance runners. Unlike Frick, we collected only one year of data, so we could not compare results by rank, as he did for runners. Instead, we computed the coefficient of variation of the 2008–09 point totals for each competition in our sample. If competitive balance is worse among women than among men, we would expect the variance (standardized by the mean point total) to be greater for women.

The first two columns of Table 15.2 show the coefficient of variation for the tournaments included in this study. While the values for men and women are fairly close, the coefficient of variation is consistently larger for women. This need not indicate, however, that women strategically enter tournaments, as the coefficient of variation for women is higher in the four championship tournaments, which are highly unlikely to be subject to strategic entry (the Four Continents Championship, the European Championship, the World Championship, and the Olympics). It is almost certain that every eligible man and woman would take part in these com-

Table 15.2 Coefficient of variation of 2008–2009, points for men's and ladies' competitions

Tournament	CV – men	CV – women	Ratio – men	Ratio – women
Trophée Eric Bompard	0.529	0.652	0.859	0.842
Skate Canada	0.496	0.671	0.805	0.867
Skate America	0.521	0.712	0.846	0.920
Rostelecom Cup	0.580	0.691	0.940	0.893
NHK Trophy	0.565	0.562	0.916	0.725
Cup of China	0.614	0.796	0.995	1.029
Grand Prix Finals	0.556	0.322	N/A	N/A
Four Continents	1.184	1.432	N/A	N/A
European Championships	0.639	0.987	N/A	N/A
World Championships	0.648	0.890	N/A	N/A
Olympics	0.617	0.774	N/A	N/A

petitions. A higher coefficient of variation may indicate a greater spread of abilities among women. We therefore treat the coefficient of variation for the Olympics as a baseline measure of competitive balance and compute the ratio of the coefficient of variation in each of the Grand Prix tournaments to the coefficient of variation in the Olympics. (We do not include the Grand Prix Final, as the participants in the final event are determined based on the results of the previous six events.) When we do that, we see even less difference between men and women, with the ratio being greater for women in three tournaments and greater for men in three tournaments as well.

The results of the OLS regressions appear in Table 15.3. Overall, the regressions fit the data very well, with adjusted R^2 s of just below 0.7 for men and just over 0.7 for women. Our findings in the first two columns of the table generally show that figure skaters respond to incentives, though their responses differ from what the existing literature would lead one to expect. The results show that the economic contest structure has a slightly negative impact on the performance of men but generally has a positive impact on the performance of women.

Two control variables have no effect on either men or women. As age has no clear a priori effect, we were not surprised that it had no significant impact.⁹ Similarly, the results show no 'home ice' advantage. Apparently, a friendly crowd does not have the same impact in figure skating that Moskowitz and Wertheim (2011) claim it has in other sports.

Table 15.3 *Determinants of free skate score*

Variable	Baseline regression		Interaction	
	Men	Women	Men	Women
Age of Competitor	0.073 (0.24)	-0.321 (1.33)	0.073 (0.24)	-0.322 (1.33)
Points in 2008–2009	0.010*** (3.71)	0.0112*** (4.71)	0.009*** (2.97)	0.109*** (3.92)
Mean Score of Short Program	-0.362 (1.22)	-0.2039 (0.60)	-0.325 (1.07)	-0.190 (0.55)
Skated on Home Ice	-2.683 (0.99)	-1.0221 (0.44)	-2.649 (0.98)	-1.079 (0.47)
Olympic Competition	1.247 (0.31)	18.6915*** (5.08)	-0.837 (0.15)	17.730*** (3.25)
World Championship	1.763 (0.49)	11.2342*** (3.78)	0.132 (0.132)	10.375** (2.22)
Score in the Short Program	1.334*** (3.80)	0.3900 (1.42)	1.309*** (3.67)	0.398 (1.43)
Rank after Short Program	0.171 (0.29)	-0.9473*** (2.99)	0.272 (0.44)	-0.922*** (2.75)
In Last Group of Skaters	-4.990* (1.66)	0.0225 (0.01)	-4.839 (1.60)	0.156 (0.06)
Points Behind Top Skater	-0.305 (0.66)	-0.308* (1.69)	-0.372 (0.77)	-0.308* (1.69)
Points × Major Championship	N/A	N/A	0.003 (0.55)	0.001 (0.24)
Constant	59.545*** (2.75)	92.520*** (5.51)	59.616*** (2.74)	91.366*** (5.21)
Adjusted R^2	0.672	0.711	0.671	0.709
Number of observations	165	145	165	145

Note: t -statistics in parentheses; * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

A third control variable, the points a skater accrued in 2008–09, had a statistically significant, positive impact for both sexes. This finding leads to the reassuring conclusion that better skaters got higher scores in the 2009–10 season. For both men and women, every additional 100 total points in the previous season led to a little more than 1.1 additional points in a 2009–10 Free Skate. It is the only variable to have a statistically significant result for both men and women.

The dummy variables that indicated whether the competition was the Olympics or the World Championships had a statistically significant, posi-

tive impact on women's but not on men's performances. Women's scores were far higher in both the Olympics and the World Championship than in the other competitions, even after we accounted for the quality of the skater. It is also possible that the stakes for men – in terms of endorsements and exhibitions – are lower for men than for women, but that lies beyond the scope of this study. Because these competitions are the most widely publicized and lead to greater professional and commercial opportunities than the other competitions, we take these results as indicating that female figure skaters respond positively to the greater incentives provided by these events.

Skaters' performance in the Short Program had a mixed impact on their performance in the Free Skate. The first measure of Short Program performance, the overall mean score of the Short Program, had no impact for either men or women. This suggests that high overall scores in the Short Program did not indicate that judges were generally lenient, nor did they indicate that judges would 'make up' for high scores by being particularly strict in their scoring of the Free Skate.

Skaters' individual performances in the Short Program had significant effects, but they differed for men and women. In fact, no variable had a significant impact for both sexes. A skater's score in the Short Program had a positive impact on men's score in the Free Skate, but it had no impact for women. The fact that the impact did not hold for women leads us to believe that this coefficient does not reflect behavior by the judges. A skater's absolute score does not reflect his or her likelihood of winning the overall competition, as it says nothing about where this score falls relative to the competition. We therefore cannot conclude anything about a skater's response to incentives from this coefficient. It could simply show that a male skater was having a good week.

The two variables that most closely reflect the incentives laid out by Ehrenberg and Bognanno (1990a and 1990b) are a skater's rank after the short program and the number of points by which a skater trails the leader after the Short Program. In both cases, a higher value of the variable reduces the chance that the skater will win the competition and that he or she will be on the podium at all. A higher rank number means that the skater must pass more competitors to catch the leading skater, and a greater point differential means that the skater has to skate that much better to catch the leaders. Thus, negative coefficients for these two variables imply that a skater has a worse Free Skate if her rank after the Short Program is worse and that she also has a worse Free Skate if she trails the leading skater by more points. Conversely, a skater who is closer to leader will perform better in the Free Skate. These responses are consistent with the incentive effects first laid out by Ehrenberg and Bognanno. Both of

these variables have a negative impact on a woman's Free Skate score but have no impact on a man's score. Female figure skaters therefore respond consistently with the predictions of the Ehrenberg–Bognanno framework, but male figure skaters do not.

The final Short Program variable, whether the skater is placed in the best group of six skaters, who perform last, fails to support the hypothesis that women respond poorly to setbacks. In fact, it suggests just the opposite. The coefficient is insignificant for women, which implies that the atmospherics surrounding being in the final group of skaters have no impact on their scores. Men, on the other hand, respond negatively to being in the final group, suggesting that they are more likely to succumb to jitters than women are.

The last two columns of Table 15.3 add an interaction effect between the major competitions – the World Championships and the Olympics – and the players' rank in 2008–09. This variable captures the interplay of rank and incentives noted in Gilsdorf and Sukhatme (2008a and 2008b). They found that more highly seeded tennis players were more likely to win a match when more prize money was at stake. While the World Championships and Olympics do not offer a direct payoff, they clearly are the most lucrative skating competitions in terms of prestige and lifetime earnings. If figure skaters behaved like tennis players, one would expect this variable to have a positive impact, as better skaters will have higher Free Skate scores in the major competitions. We find no such impact, as the coefficient on this variable is statistically insignificant, and including this variable has minimal impact on the other coefficients.

15.6 CONCLUSION

As with many other areas of economic theory, sports provide an excellent 'laboratory' for the study of how women and men respond to economic contests. Ironically, the results from this laboratory frequently contradict the findings of truly experimental studies. The experimental literature consistently finds that women respond worse than men to tournament settings. Non-experimental studies using data from tennis (Gilsdorf and Sukhatme, 2008a and 2008b) and golf (Paserman, 2010) find no difference in how men and women respond. Studies of golf and tennis, however, cannot control perfectly for weather conditions or for interactions among the participants. Our study of figure skating builds on previous sports studies by controlling for the conditions under which the participants perform and minimizing the interaction between the participants.

Using data from 11 skating contests from the 2009–10 skating season, we find that women respond positively to incentives. Our results support previous non-experimental findings and contradict much of the experimental literature. We go beyond the previous literature in showing that female figure skaters respond more positively to incentives than male skaters do.

Because the most important figure skating events do not offer an explicit prize, we cannot directly measure how monetary incentives affect performance. However, we show that women respond very strongly to being on the big stage provided by the Olympics and World Championships, while men do not respond at all. Because winning at the Olympics and World Championships is far more prestigious and more lucrative (albeit indirectly) than the other tournaments, one can interpret this result as saying that women respond positively to a higher overall purse, as Ehrenberg and Bognanno (1990a and 1990b) found for male golfers.

We also find that women who are more highly ranked and closer to the leader after the Short Program score more highly in the Free Skate. These results show that skaters who are higher up the reward gradient entering the Free Skate respond positively to the greater incentive to perform well. This result is again analogous to Ehrenberg and Bognanno's findings for male golfers.

Contrary to Ehrenberg and Bognanno's findings for golfers, male skaters do not respond to either the purse size or their position on the reward gradient. A better absolute score in the Short Program leads to a better score in the Free Skate, but the absolute score says nothing about the skater's position relative to his competitors. Moreover, we find that male skaters respond negatively to the pressure of being among the final six skaters – those who have the best chance of finishing 'on the podium'.

We also have two results that contradict previous non-experimental findings. Unlike Gilsdorf and Sukhatme (2008a and 2008b), who find that favorites in elimination tournaments are more likely to win a match when greater rewards are on the line, we find that the better skaters (as measured by total points in the previous season) do no better in the Olympics and World Championships than in the ISU tour events.

Finally, we find no evidence that female figure skaters enter events strategically in order to avoid competing with one another. If women sought out less-competitive fields, then the coefficient of variation of the skaters' ISU points earned in the 2008–09 season (our measure of the talent of the skater in the 2009–10 season) for the six ISU Grand Prix events in 2009–10 should be higher for women than for men. Instead, we

find that the coefficient of variation is greater for men in three of the six events. This finding suggests either that female figure skaters behave differently from the female distance runners studied by Frick (2011) or that female figure skaters do not have enough events to be able avoid other elite competitors.

When combined with the results from other sports, our key findings indicate that economic contests might not place women at the severe disadvantage that the experimental studies suggest in either sports or broader labor markets. The conflict between the two sets of results is puzzling until one recognizes that an experimental setting fails to capture an important aspect of the job market. Experimental studies rightly take great care in randomly assigning people to tasks, but the labor market is hardly random. Workers – like athletes – self-select into activities for which they are particularly well-suited and strongly motivated. We find – and many of the other results that use data from sports indicate – that such women respond at least as well as men to the incentives that ROTs provide. Further work will show whether this finding extends to women in the corporate world as well.

NOTES

* We thank Jane Ruseski for her helpful comments on an earlier draft of this chapter and Melanie Leeds for her able research assistance.

1. Their findings can be extended to a larger workforce.
2. The probability of winning the prize was $(50 + \Delta)/100$, where Δ is the differential in the scores of the two participants.
3. For evidence that reinforces this result and finds a similar result for men on the PGA tour, see Chapter 5 in this volume.
4. Technically, one could try to get at this by looking at such measures as unforced errors and winning shots.
5. Some of the large competitions also have a preliminary round, though we ignore that here.
6. The spiral sequence was deleted from the Short Program starting in the 2010–11 season.
7. Some nations provide supplemental payments and other benefits, such as exemption from otherwise mandatory military service (in the case of South Korea) for world champions or Olympic medalists. In addition, a country's representation in the next year's World Championships depends on the placement of its skaters in the current championships.
8. The Grand Prix events were the Cancer.net Skate America, the Cup of China, HomeSense Skate Canada, the NHK Trophy, the Rostelecom Cup, the Trophée Eric Bompard, and the Grand Prix Final. The regional events were the European Championships and the Four Continents Championship.
9. We had wanted to use age squared as well, but, because the ages of the competitors are from such a narrow range, age and age squared were too highly correlated to use in the same regression.

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APPENDIX 15A1 THE COMPOSITION OF THE MEN'S AND LADIES' SHORT PROGRAM AND FREE SKATE

Men's Short Program required elements:

- Lasts 2:50
- Three Jump Elements
 - A double or triple axel jump
 - A triple or quadruple jump immediately preceded by connecting steps
 - A jump combination consisting of a double jump and a triple jump, two triple jumps, or a quadruple jump and a double or triple jump
- Three Spin Elements
 - A flying spin
 - A camel or sit spin with one change of foot
 - A spin combination with one change of foot
- Two different step sequences (Changed to one in 2010)
 - Two of: straight line, circular, or serpentine

Ladies' Short Program required elements:

- Lasts 2:50
- Three Jump Elements
 - A double or triple axel
 - A triple jump preceded by connecting steps
 - A jump combination (one double and one triple or two triple jumps)
- Three Spin Elements
 - A flying spin
 - A layback spin
 - A spin combination with one change of foot
- Two Sequences
 - One step sequence (straight, circular, or serpentine)
 - One spiral sequence

Men's Free Skate required elements:

- Lasts 4:30
- Jumps:
 - Up to eight jump elements

- At least one – but no more than three – must be an axel
- Combinations
 - No more than three combinations/sequences
 - No more than one three-jump combination
- Spins
 - No more than three spins
 - All spins must be of a different nature
- Step Sequence
 - At most two sequences
 - May be straight-line, circular, or serpentine

Ladies' Free Skate required elements:

- Lasts 4:00
- Jumps:
 - Up to seven jump elements
 - At least one – but no more than three – must be an axel
- Combinations
 - No more than three combinations/sequences
 - No more than one three-jump combination
- Spins
 - No more than three spins
 - All spins must be of a different nature
- Sequences
 - At most two step sequences
 - One step sequence
 - One spiral sequence

APPENDIX 15A2 THE FIGURE SKATING SCORING SYSTEM

The International Skating Union (ISU) reformed the way judges scored figure skating performances in the wake of allegations that the results of the 2002 Olympic figure skating competition had been rigged.¹ For many years, commentators had accused judges of favoring competitors from their own countries. The 2002 Winter Olympics went beyond jingoism to score-trading in which a French judge agreed to rate a Russian pairs team highly if a Russian judge gave high scores to a French ice dancing team.

The ISU tried to remedy the problem of inappropriate scoring with several changes. First, judges are now anonymous, which reduces the ability of judges to trade scores or of political authorities to influence their countries' judges. Second, judges are no longer bound by the 6.0 scale. Judges evaluate the quality of each element according to a fixed scale. For example, a successful triple axel is worth 8.5 points (with a 10 percent bonus for those performed more than halfway through a performance). Judges assign the axel a grade of execution (GOE), which can range from +3 to -3. Rather than allowing each judge to apply his/her own GOE, the competition computes a group GOE by randomly selecting nine of the 12 judges, deleting the high and low score, and computing the average of the remaining seven scores. Previously, nine identifiable judges entered their score directly, with all nine scores counting. The grade is then applied to the base score according to a predetermined weighting system. A technical panel assists the judges by identifying each element in real time and providing instant replay, should it be needed.

As before, the technical score is supplemented by a more subjective measure, now called the program component score. This evaluation is based on skating skills, execution, interpretation, and timing. The judges have less room for subjectivity, however, as they must assign scores to a predetermined set of components in increments of 0.25.

In addition to reducing the role played by subjective judgment and hence the chance to rig scores, the new system more directly links a skater's rank to his or her own performance. Under the old system, skaters were evaluated ordinally. As a result, a skater who was several places below another after the short program could not possibly catch up unless the other skater performed poorly and fell several places in the free skate. Now, skaters can make up any difference after the short program if they skate well enough in the free skate.

Note

1. For a detailed description of the ISU scoring system, see US Figure Skating (2010).