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# TEAM VS. INDIVIDUAL TOURNAMENTS: EVIDENCE FROM PRIZE STRUCTURE IN ESPORTS

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# TEAM VS. INDIVIDUAL TOURNAMENTS: EVIDENCE FROM PRIZE STRUCTURE IN ESPORTS[3]

This study tests the implications of tournament theory using data on eSports (video game) competitions. We incorporate team production with the theory of rank order elimination tournaments since in our analysis, competitors in an elimination tournament are groups rather than individuals. In this setting, the issue of proper incentives becomes more complicated than in the normal tournament model. Our findings demonstrate that the prize structure is convex in rank order which means that the contestants in eSports tournaments are risk averse. The results for the team games are more consistent with the tournament theory than the results for individual games. From the practical point of view, we provide decision-makers in both sports and business with the insights about the compensation design with respect to importance of the competition and its type.

JEL Classification: Z20, J3

Keywords: tournament theory, eSports, video games, team production.

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# Introduction

Lazear and Rosen (1981) introduced rank order tournaments as optimal labor contracts and Rosen (1986) extended the analysis to elimination tournaments. Lazear and Rosen (1981) suggested large salary dispersion can lead to greater effort and higher productivity. Levine (1991) argues that by equalizing salaries a firm may improve cohesion and, therefore, productivity. Ehrenberg and Bognanno (1990) tested the theory by examining the impact of prize structure in golf tournaments on performance of golfers. Since that time, the predictions of tournament theory have been studied in a number of sporting contexts including auto racing (Becker and Huselid, 1992; Depken and Wilson, 2004), marathons (Frick et al., 2007), tennis (Gilsdorf and Sukhatme, 2008) and in the presence of superstars (Brown, 2011).

A closely related literature has developed examining production in teams. Beginning with Alchian and Demsetz (1972) team production models have focused on getting incentives right such that team members do not shirk their responsibilities or sabotage the efforts of the team. For example, Winter (2004) and Gould and Winter (2009) develop models where individual team members may increase or decrease their effort in response to increased effort by teammates. Ramaswamy and Rowthorn (1991) adapt an efficiency wage model to develop an efficient distribution of wages in which they find that the worker with the greatest ability to sabotage the group effort gets the highest wage.

Empirical work has tested the tournament versus cohesion theory both in the business world and in the sporting context. Evidence is mixed in the sporting context with improved performance with more equal salary distribution in Major League Baseball (Bloom, 1999; DeBrock et al., 2004; Depken, 2000) but in the National Basketball Association performance improves with less equal distribution (Simmons and Berri, 2011) or there is no effect (Berri and Jewell, 2004; Katayama and Nuch, 2011). Franck and Nüesch (2011) and Coates et al. (2014) study salary dispersion and team performance in the Bundesliga and Major League Soccer, respectively. Frank and Neusch find a U-shaped relationship while Coates et al. find that team production falls with more unequal salary distribution. Frick et al. (2003) study the National Football League and Kahane (2012) studies the National Hockey League.

This paper incorporates team production with the theory of rank order elimination tournaments. Existing literature focuses on individual sports, golf, tennis, marathons and auto racing, of which only tennis is of the elimination tournament variety, or team sports which are not elimination tournaments. In our analysis, competitors in an elimination tournament are groups rather than individuals. In this setting, the issue of proper incentives becomes more complicated than in the normal tournament model. The tournament organizer will want to induce teams to compete especially hard for the first prize, as in the standard model, but the tournament organizer and the team organizer will want to induce the best effort out of all members of a team.

The competition studied is video games. The paper begins by describing video game competitions including documenting the growth in competitive video gaming as well as in the value of prizes to be won. There is an active player market as well, with players being recruited to top teams by investors and compensation sufficiently large that players need not have other jobs. The paper describes tournament theory and provides an overview of the empirical literature before turning to the data for this analysis and the methodology. The paper ends with a presentation and discussion of empirical results and a conclusion.

# Theoretical background

*eSports*

To date there is no common definition of eSports. Wagner (2006) defines eSports as "an area of sport activities in which people develop and train mental or physical abilities in the use of information and communication technologies". Witkowski (2012) criticized this definition because many aspects of traditional sports are computer-assisted or computer-mediated. Another definition is available from Hamari and Sjöblom (2015), who regard eSports as "a form of sports where the primary aspects of the sport are facilitated by electronic systems; the input of players and teams as well as the output of the eSports system are mediated by human-computer interfaces".

Since eSports are an emerging form of activity, there are only a few studies devoted to this particular field. In general, the literature on eSports is very limited, with most papers focusing on the definition of this phenomenon and its future implications (Seo, 2013; Seo and Jung, 2014; Taylor, 2012; Taylor and Witkowski, 2010).

The history of eSports tournaments is quite long. The first such event took place at Stanford University in 1972. It was called the "Intergalactic Spacewar Olympics" and the prize was a subscription to *Rolling Stone* magazine (Hiltscher and Scholz, 2015). However, the industry of eSports events considerably evolved during the 1990s. With the establishment of the Cyberathlete Professional League (CPL) in 1997, tournament prize pools became larger due to corporate sponsorship and an increasing number of spectators, both online and live (Gaudiosi, 2013). For now, CPL is inactive and has been substituted by the Electronic Sports League (ESL). Until 2011, the largest eSports event was the World Cyber Games (WCG). This event was regarded as the eSports Olympics (Svoboda, 2004), whereas the biggest event is currently DreamHack, which comprises tournaments for the most popular games. Sponsorship is the core funding system for eSports tournaments (Taylor, 2012, p.154). There are different kinds of sponsors. Game producers are interested in promoting their games through these tournaments. Hardware producers are also natural eSports sponsors (SteelSeries, MSI, Intel). There are also companies that promote their goods using eSports, such as Coca-Cola ("Coca-Cola and Riot Games Renew Partnership for 2015: The Coca-Cola Company", 2015). Seo's (2013) study was one of the first attempts to analyze the marketing aspects of eSports.

eSports games can be categorized into different genres. For example, games can be multiplayer online battle arena games, real-time strategy games or tactical first-person shooter games. There are sports games, racing games and fighting games. However, based on cumulative tournament prize money, the top five games come from the multiplayer online battle arena, real-time strategy or tactical first-person shooter genres. These games are Dota 2, League of Legends, StarCraft II, Counter-Strike: Global Offensive, and Counter-Strike ("Top 50 Games Awarding Prize Money - eSports Game Rankings: eSports Earnings", 2015).

There are offline (so called "LAN" tournaments; LAN is a local area network in contrast to internet-based or online tournaments) and online competitions for most games. The leading tournaments are held offline and take place in front of live spectators. The most common format is a double-elimination system, whereas the format in the case of a low number of participants is a single-elimination system. Big events also have a group stage as a preliminary competition before the playoffs stage. Parshakov and Zavertiaeva (2015) underline the difference between prizes for online and offline tournaments. They show that 78% of gamers prize money is earned from offline tournaments. eSport competitons are structured like many regular sport competitions and a natural question is to what extent their incentive structure follows tournament theory.

*Tournament theory and prize structure*

Tournament theory is concerned with groups of agents that compete for a prize. The key feature of tournament theory is that the reward is based on relative rank (Lazear and Rosen, 1981). The reward for tournament winners is designed to maximize the effort of all contestants. Since the reward can be either monetary or nonmonetary, tournament theory has implications in a wide range of fields. For example, tournament theory explains how judges compete for the ultimate prize, which is a decision from the US Supreme Court (Choi and Gulati, 2004), or how contract growers vie to supply broiler chickens to Perdue and Tyson (Knoeber and Thurman, 1994). It also explains compensation structures (Messersmith et al., 2011). Sporting events provide a natural context for tournament theory (Depken and Wilson, 2004; Melton and Zorn, 2000).

To maximize effort, the prize spread in a tournament should be optimized. By prize spread, we mean the difference between the prize for winning the current level and the prize for winning the next level in sequential elimination tournaments (Becker and Huselid, 1992; Messersmith et al., 2011). A sequential elimination is a tournament organized in such a way that winners of the current stage compete in the next stage against other winning actors (Choi and Gulati, 2004; O'Neill and O'Reilly, 2010). As such, the optimal prize structure involves a prize spread that maximizes the ratio of actor effort to the prize. If it is too small, actors are not incentivized to maximize their effort. If it is too high, actors take on an additional risk of losing and need to be separately compensated for such a risk (DeVaro, 2006; Kepes et al., 2009). Using data from automobile racing, some studies find that nonlinear rewards may be associated with more risky behavior (Depken and Wilson, 2004; Schwartz et al., 2007).

A number of theoretical papers show that tournament theory suggests a reward structure that allows for a competition to be organized with optimal effort (Baker et al., 1988; Lazear, 1999; Lazear and Rosen, 1981; Prendergast, 1999). Rosen (1986, p.705) shows that, for risk-neutral contestants, the inter-rank spreads are constant until the final stages, at which point the inter-rank spread will exhibit a distinct and substantial increase in this linear function. Rosen also demonstrated that "if players are risk-averse, the incentive maintaining prize structure requires strictly increasing interrank spreads, with an even larger increment between first and second place." (Rosen, 1986, p. 706). We formulate two research hypotheses concerning the structure of prizes in eSports:

1. the function describing the relationship between prize and rank is convex;
2. the difference in prize (inter-rank spread) for the final stage contestants, relative to the lower stage contestants, should be extraordinarily large in relation to the inter-rank spread for the contestants in the lower stages.

Such hypotheses were tested in the business context. Lambert et al. (1993) and Conyon et al. (2001) found convex relationships between executive pay and organizational levels.

However, in business, there are significant nonmonetary incentives for the contestants. This presents a limitation in such research, since tournament theory supposes that “the prize is presumed to be the actors’ predominant motive. Research that incorporates more complex social understandings of actor objectives may be beneficial” (Connelly et al., 2013, p.29). However, since the reward is mostly performance-based in eSports (Parshakov and Zavertiaeva, 2015), this provides us with perfect data for testing the implications of tournament theory.

## Data

To test the implications of tournament theory in the context of eSports, we use data on prizes that players win in tournaments. We obtained this information from the results of the eSports Earnings project. This resource is based on freely available public information on different tournaments in eSports, the nicknames of winners and the sums won. The eSports Earnings website contains information on each gamer’s prize earnings for each tournament (in dollars) for the period from 1999 to 2014. Nominal prizes are corrected in line with the official US inflation rates.

Table 1 presents some of the descriptive statistics for prizes and prize concertation. A typical tournament has prizes for the top eight winners. For some tournaments, especially individual, this number might be lower. For descriptive purposes, we calculate the Herfindahl-Hirschman Index (HHI) to estimate the concentration of the prizes. HHI is calculated as follows:

$$HHI_i = \sum_{i=1}^{n} \left( \frac{prize_i}{\sum_{i=1}^{8} prize_i} \cdot 100 \right)^2$$

where $prize_i$ is the prize of the gamer of rank *i* and *n* is the number of winners. The higher the HHI, the bigger the spread between winners’ prizes. For the perfectly concentrated tournament, where the winner takes all of the prize pool, HHI is equal to 10,000.

As one can see from Table 1, the total prize pool varies game by game. However, even for one game, the variation in prize pool is large. For example, for the Multiplayer Online Battle

Arena genre, the prizes vary from USD 3 million to USD 10 million. First Person Shooter is the genre with the highest mean prize. HHI varies largely according to genre. For most genres, there are tournaments in which only the winner gets a prize. Mean HHI is about 5,000 to 6,000, with the exception of the Sports Simulator genre, which is significantly more concentrated.

Table 1. Descriptive statistics of total prize and HHI by genre of game. Sorted by mean of total prize.

| Genre | Total prize | | | HHI | | |
|---|---|---|---|---|---|---|
| | Min. | Mean | Max. | Min. | Mean | Max. |
| First person Shooter | 25 | 11,161 | 1,000.000 | 907 | 5,868 | 10,000 |
| Sports | 52 | 1,142 | 140,000 | 2,578 | 9,280 | 10,000 |
| Role playing game | 500 | 1,551 | 50,000 | 3,650 | 6,736 | 6,800 |
| Fighting game | 20 | 2,244 | 53,700 | 1,983 | 4,684 | 10,000 |
| Multiplayer Online battle arena | 3 | 25,213 | 10,931,103 | 313 | 6,510 | 10,000 |
| Collectible card Game | 54 | 6,700 | 250,000 | 1,062 | 6,496 | 10,000 |
| strategy | 18 | 7,064 | 250,000 | 48 | 6,740 | 10,000 |

Figure 1 illustrates the dynamics of the average prize pool and HHI. There is a clear positive trend in the total prize pool with a boom in 2011, where the average prize pool doubled. Regarding the spread measured by HHI, there is no obvious trend.

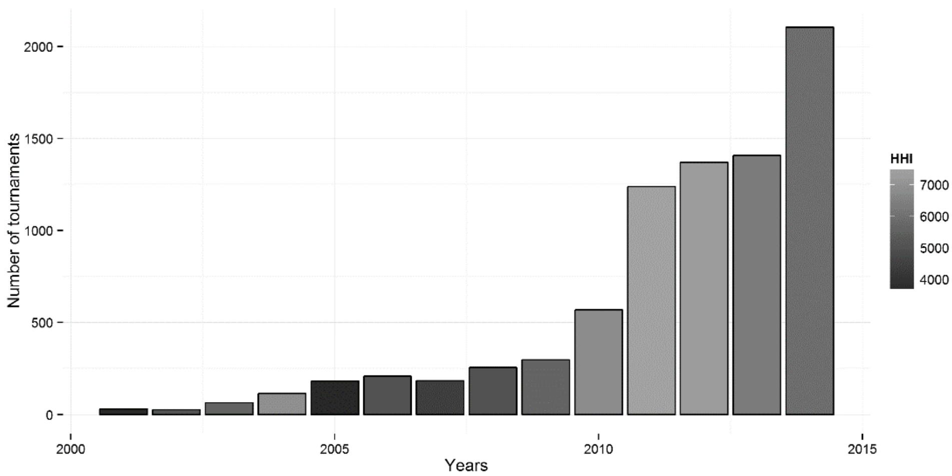


Figure 1. Number of tournaments and HHI dynamics - the shading of the bar reflects the average HHI of a particular year tournaments

Table 2 contains the mean prize and HHI for different types of game and types of tournament organization. The mean prize for team games is significantly higher, although it should be noted that this prize is divided between team members. Given that the average team size is four to five, the mean prize is more or less the same. The concentration of individual games is slightly higher. Regarding the type of tournament, the mean prize for an offline tournament is much higher. This is because all of the top tournaments are held offline (so called "LAN" tournaments; LAN is a local area network in contrast to internet-based or online tournaments). Online tournaments are more concentrated.

Table 2. Descriptive statistics of total prize and HHI by type of game and type of tournament

| Game type | N | Mean HHI | Mean prize |
|---|---|---|---|
| Individual game | 5,627 | 6,622 | 5,804 |
| Team game | 3,906 | 5,898 | 19,590 |
| Offline tournaments | 24,872 | 3,959 | 27,722 |
| Online tournaments | 39,968 | 7,854 | 2,076 |

Figure 2 illustrates the relationship between the prize and HHI. As one can see, there are perfectly concentrated team and individual tournaments. Interestingly, the prize pool for most of these tournaments is relatively low. Since we are interested in analyzing the spreads, we exclude the perfectly concentrated tournaments (HHI=10 000) from further analysis. This represents 39% of the sample, with 34% for team games and 66% for the individual games. Regarding the direction, there is a clear negative correlation between HHI and total prize pool. So, the larger the prize pool, the smaller the concentration of prizes. If the prize pool is small, the prize structure is usually concentrated: it does not make sense to divide a small prize pool. However, this relationship seems to be nonlinear.

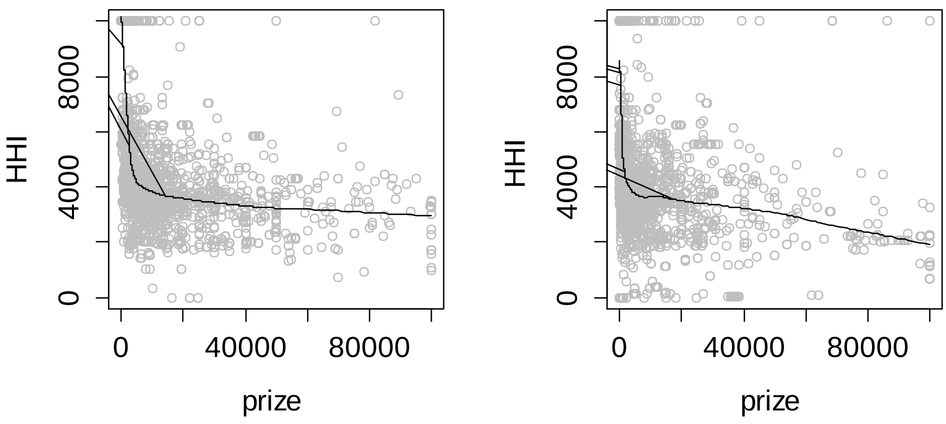


Figure 2. Relationship between the prize and the concentration (HHI) of prizes for team (left panel) and individuals (right panel). Scales for both graphs are the same. Although the maximum prize is truncated for the purpose of presentation, this does not affect the locally weighted polynomial regression (black line).

Figure 3 shows the spread between prizes for places from first through eighth for team and Individual tournaments. The spreads appear as to be expected from tournament theory: the spread for the top ranks is much higher than for the lower ranks. However, we need a formal test to understand whether the prize spreads in eSports follow tournament theory.


Figure 3. Prize distribution by rank (from first to eighth) for team (left panel) and individual (right panel) games.

## Methodology

We estimate the following regression:

$$\log(prize_{ijt}) = \alpha + \sum_{j=1}^{7} \beta_j rank_j + \sum \beta_g game_g + \sum \beta_k country_k + \sum \beta_t year_t + \varepsilon_{ijt},$$

where $rank_j$ represents dummy indicators of the final tournament rank of the gamer/team. The eighth rank is the omitted category. The dummy indicators $game_g$, $country_k$ and $year_t$ represent controls for game, country of tournament and year, respectively. We use OLS with robust standard errors for the estimations.

The first hypothesis we test supposes the convex relationship between rank and prize. In such a case, we should observe the following conditions:

$$\beta_7 \geq 0$$

$$(\beta_6 - \beta_7) \geq \beta_7$$

$$(\beta_5 - \beta_6) \geq (\beta_6 - \beta_7)$$

$$(\beta_4 - \beta_5) \geq (\beta_5 - \beta_6)$$

$$(\beta_3 - \beta_4) \geq (\beta_4 - \beta_5)$$

$$(\beta_2 - \beta_3) \geq (\beta_3 - \beta_4)$$

$$(\beta_1 - \beta_2) \geq (\beta_2 - \beta_3)$$

In words, seventh place has a larger prize than eighth place, the increment for sixth over seventh is greater than the increment of seventh place over eighth place, and so on. Each move up the ranking gives a larger boost to the payoff than did the previous move up in rank. This test procedure is outlined in Lambert et al. (1993) and Conyon et al. (2001). We use the term “convex” to describe a function in which prize spreads across adjacent ranks are non-decreasing and concave to the function with non-increasing spreads.

## Empirical Results

The results of regression analysis are presented in Table 3. Models 1 to 3 are estimated based on the total sample, while models 4 to 6 are estimated only for offline tournaments and models 7 to 9 concern online tournaments. Since we use the log of a prize as the dependent variable, the coefficients indicate the average percentage difference between an omitted category and the gamer/team rank. The results are comparable with what one would expect from tournament theory: the prizes for the top ranks are significantly higher than for lower ranks. However, the number of significant ranks varies according to the type of tournament and game. We further analyze results in two contexts: (1) top (offline) tournaments vs. low (online) tournaments, and (2) team vs. individual games.

The comparison of the major and minor tournaments provides information about the structure of rewards in the case of different prize sizes. Since each game in our sample involves both online and offline tournaments, it is possible to control all the necessary parameters except for the type of tournament (offline or online).

The results indicate a significant difference between offline and online tournaments (models 4 and 7). For online tournaments only, two ranks are significant, while for the offline six ranks are significant offline. Therefore, in order to maximize the effort in a major tournament, the organizer should design the prize structure in such a way that almost all of the contestants will win a prize, which significantly differs from the previous rank prize. This might be explained by the fact that competition is high and the chances of winning, even for a strong contestant, are lower than in a lowly tournament. Since the probability of winning is lower, the prize is consequently higher, even for lower ranks.

Interestingly, the results for team and individual games are similar (models 2 and 3). The number of significant ranks is the same; moreover, the spreads also look similar. The type of tournament explains much more than the type of game involved.

Table 3. Regression results

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| | Offline + Online | | | Offline | | | Online | | |
| | All | Team | Individual | All | Team | Individual | All | Team | Individual |
| Rank 1 | 1.6034*** | 1.6384*** | 1.6500*** | 1.9577*** | 1.8946*** | 2.0445*** | 0.9872*** | 1.0788*** | 0.9739*** |
| | (0.0450) | (0.0662) | (0.0599) | (0.0496) | (0.0775) | (0.0629) | (0.0925) | (0.1175) | (0.1286) |
| Rank 2 | 0.8409*** | 0.8979*** | 0.8708*** | 1.1960*** | 1.1694*** | 1.2508*** | 0.2234** | 0.3139*** | 0.2106 |
| | (0.0451) | (0.0664) | (0.0599) | (0.0495) | (0.0776) | (0.0626) | (0.0927) | (0.1185) | (0.1287) |
| Rank 3 | 0.3604*** | 0.4655*** | 0.3531*** | 0.6064*** | 0.6181*** | 0.6213*** | -0.1196 | 0.0926 | -0.2037 |
| | (0.0461) | (0.0672) | (0.0615) | (0.0497) | (0.0776) | (0.0629) | (0.0968) | (0.1240) | (0.1340) |
| Rank 4 | 0.3115*** | 0.2885*** | 0.3758*** | 0.4948*** | 0.4329*** | 0.5476*** | -0.0893 | -0.0906 | -0.0502 |
| | (0.0488) | (0.0706) | (0.0656) | (0.0525) | (0.0810) | (0.0668) | (0.1024) | (0.1314) | (0.1423) |
| Rank 5 | 0.0981* | 0.1330* | 0.0777 | 0.1324** | 0.1335 | 0.1158 | 0.0921 | 0.1863 | 0.0419 |
| | (0.0544) | (0.0800) | (0.0720) | (0.0573) | (0.0908) | (0.0708) | (0.1201) | (0.1505) | (0.1684) |
| Rank 6 | 0.0751 | 0.0934 | 0.0664 | 0.1085* | 0.0976 | 0.1016 | 0.0471 | 0.1023 | 0.0226 |
| | (0.0551) | (0.0825) | (0.0721) | (0.0579) | (0.0930) | (0.0709) | (0.1221) | (0.1604) | (0.1684) |
| Rank 7 | 0.0193 | 0.0215 | 0.0163 | 0.0393 | 0.0516 | 0.0271 | -0.0308 | -0.0697 | -0.0028 |
| | (0.0567) | (0.0864) | (0.0735) | (0.0593) | (0.0970) | (0.0713) | (0.1268) | (0.1731) | (0.1723) |
| Game dummies | Included | Included | Included | Included | Included | Included | Included | Included | Included |
| Year dummies | Included | Included | Included | Included | Included | Included | Included | Included | Included |
| Country dummies | Included | Included | Included | Included | Included | Included | Included | Included | Included |
| Constant | 6.5405*** | 5.3320*** | 4.3872*** | 5.9175*** | 5.1382*** | 3.7534*** | 6.4077*** | 5.8800*** | 6.3452*** |
| | (0.3244) | (0.3436) | (0.2407) | (0.3280) | (0.3659) | (0.1864) | (0.2395) | (0.2394) | (0.2535) |
| Observations | 17,435 | 7,549 | 9,886 | 10,895 | 5,011 | 5,884 | 6,540 | 2,538 | 4,002 |
| R-squared | 0.5859 | 0.4709 | 0.5778 | 0.6013 | 0.4886 | 0.6356 | 0.4137 | 0.2704 | 0.2416 |

Table 3 presents a comparison of prize spreads, which take into account both dimensions. It only contains coefficients for those ranks that significantly differ from lower ranks, for example, $(\beta_1 - \beta_2) \geq (\beta_2 - \beta_3)$, as discussed in the methodology section. As this table shows, even for major tournaments, the spreads are different with respect to the game type (individual and team). This difference is much higher for minor tournaments. Therefore, there is a difference between the motivation of groups and individuals, such that this difference increases along with the reward and the status of the competition.

Table 3. The comparison of prize spreads of different types of tournaments and games

| | **Team** | **Individual** |
|---|---|---|
| **Top** | 1.89<br>1.17<br>0.62<br>0.43 | 2.04<br>1.25<br>0.62<br>0.55 |
| **Low** | 1.08<br>0.31 | 0.97 |

## Conclusion

Lazear and Rozen's tournament theory is devoted to optimal labor contracts. It has been supported by many subsequent pieces of empirical research in different fields (Choi and Gulati, 2004; Depken and Wilson, 2004; Knoeber and Thurman, 1994; Melton and Zorn, 2000; Messersmith et al., 2011). In our study we find empirical evidence that prize spreads in eSports tournaments follow the tournament theory of Lazear and Rosen (1981) and Rosen (1986). This means that tournament organizers are interested in maximizing the participants' effort and productivity similar to traditional competition in sports and business. Another similarity is that, according to our results, the prize structure is convex in rank order. According to Rosen (1986, p. 706), this means that the contestants in eSports tournaments are risk averse. One would expect that gamers are risk-loving, but are similar to CEO and other board executives (Conyon et al., 2001; Lambert et al., 1993) in terms of risk-aversion.

Interestingly, for the low-level tournaments the prize spread is smaller. Since in tournament theory prize spread can be treated an indicator of the degree of risk-aversion, one can conclude that the risk aversion of the particular contestant varies among the competitions of different levels.

Interestingly, the results for the team games are more consistent with the tournament theory than are results from individual games. This raises interesting questions about production in teams and payoffs to performance. For example, while teams in eSports tend to share prize money equally a natural question is whether this distribution produces optimal performance. Team members may shirk because their share of the prize is the same with or without great effort. In all types of competitions, tournament organizer does not observe the effort of the contestants. However, in team competitions the manager of a team does not observe the effort of each player, so the level of information asymmetry is even higher than in individual competitions. Another important difference is that in individual competitions the contestant set the goal by himself while in team competition the manager or team leader is doing this. This might influence the motivation of particular team members. For these reasons, combining team production and tournament theories and developing a model of optimal tournament design for competitions of teams is potentially interesting from both business and sport point of view.

From the practical point of view, our findings are useful to people who make decisions about compensation schemes both in sports and business. We provide such decision-makers with the insights about the compensation design with respect to importance of the competition and its type. For example, the more important the tournament is, the higher should be the prize spread, it is insufficient to increase only the prize pool. Also, the compensation structure should be different for the teams and individuals.

Our findings are subject to at least two limitations. First, results obtained in the framework of this project may not be transferable to other sports because of the features of eSports. Second, we assume the tournaments are designed in a such way to maximize the effort.

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