The Fight for Contestants

A.D. Quintino Pereira

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Abstract

This paper examines the relationship between potential participants and the prize structures of StarCraft II tournaments. The study found that when tournament organizers aim to maximize participation of top ranked players, a multiple prize structure is optimal if sensitivity is sufficiently high; a single prize structure is optimal if sensitivity is sufficiently low. Furthermore, steep prize structures and the total prize pool are strong significant performance incentives for participants in tournaments with a short duration. The empirical data from professional StarCraft II tournaments show that, over the past couple of years, the prize structures of tournaments in general have become significantly flatter.

To,

My Father and Mother thank you for all your love and support

Dana thank you for your advice and patience

Jeff thank you for your words of wisdom

Table of content

1 Introduction

If life is a game, I'm beating it on hard mode before I die.

Nick "Tasteless" Plott

It is human nature to compete with one another, a desire and primal urge that pushes us forward to do great things. This trait is the reason mankind has grown from simple hunters and gatherers, to a society that literally reaches for the stars. Throughout history, extending as far back as the existence of mankind, sports have always been the way for many to fulfil that desire, earning them reputation and prestige. The history of sports tells us the story of social changes in human society. From brutal wrestling games in 7000 BC, and the creation of the Olympic games in Ancient Greece, to the first "World Mind Sports Games" in 2008. As society changes so does sport.

In little over two decades the internet and web technologies have transformed entertainment, media, and society. For example, the Apple online music store is the largest music retailer in the world. The introduction of tablets have fundamentally changed the way people read and buy books. The importance of computers in everyday lifestyles have led to an internet focused-culture. People aren't just online for work but order food, clothing, medicine, and entertainment with the click of a button. This has given way for video games to be played and loved by billions. Fifteen years ago video games were something for teenagers and the tech-savvy. Nowadays anyone with a mobile device can play some kind of videogame suitable for them.

Due to this shift in society, there has been a growing amount of players, tournaments, fans and media attention for video games and electronic-sports. E-sports have been around since the early 1990's, but have only recently really gained momentum with a wide audience. This has led to an increased interest from companies and sponsors, which have propelled e-sports over these past three years to arguably be considered a professional sport. Leading the charge within e-sports is a game called Starcraft II, made by Activision Blizzard.

Starcraft II is a real-time strategy game (RTS). It is the first one that has been developed with the purpose of e-sports in mind. Never before had there been a franchise and developer so committed to the idea of e-sports as Activision Blizzard with Starcraft II. Through continuous improvements, and ground-breaking software technology StarCraft II is truly a technological wonder. With net revenues of over $1.32 billion for 2013 Q1, and total assets of $14.2 billion Activision Blizzard has more than just their knowledge to back up their commitment.

Yet, despite all the technological wonder and drastically changed society, StarCraft II as a e-sport faces the same problem as those wrestling contests in 7000BC. The problem that competition is not limited to the players in the contest. But the contests themselves are in competition with each other as well, whether it is about publicity, sponsor contracts, or prestige. It boils all down to the same thing, and that is the fight for participants.

The most common and recognisable incentive to attract contestants in any competition, is rewarding monetary prizes for competing. The general marketing strategy for any tournament is publicly stating how much money is at stake. This “reward incentive” can be seen everywhere: firms offer attractive wages to attract highly skilled applicants; parents promise allowances to their kids for doing home chores, even Santa Clause himself keeps a naughty-or-nice list to incite good behaviour. New prize structures are created and tweaked each day to serve a specific function in tournaments.

Prize structure might be the most recognisable incentive, it is however not the only thing that influences potential participants. In order to win or have a chance at any of the prizes, players need to exert effort. Intuitively, players care about the influence of effort on the outcome of a tournament[1]. After all, competitions are created to crown the best competitor. Firms use labour tournaments to sift out the most capable workers. It’s only logical that effort should affect the outcome of a tournament. Depending on the tournament, players’ efforts influence the tournament outcomes to different degrees. In a lottery, effort has no influence

[1] Lazear & Rosen (1979)

on the outcome. By contrast, a house is more than likely always going to be sold to the highest bidder.

The degree to which the outcome depends on the effort of the participants is called sensitivity. Imagine three players who can enter two different contests, which are mutually exclusive with each other. Contest A has a single “winner takes all” prize structure, contest B has a flatter multiple prize structure. First, let’s assume the sensitivity for both contest A and B is zero, which means that the outcome is completely dependent on luck. In this case, it means each participant will exert zero effort. Since, whatever the players do, it won’t affect the outcome and therefore their prize. The expected payoff for participants is higher when entering contest A, because on average, entering contest A will give a larger reward. Hence, when sensitivity is zero, participants prefer a single prize structure.

Finally, let’s assume sensitivity is infinite for both contest A and B. Now, the outcomes are completely independent on luck. The players know this, and choose their effort levels simultaneously without knowing their opponents’ effort. The expected payoff now depends on the exerted effort and prize structure. The result is that participants prefer contest B over contest A. Players want to be compensated for their efforts and competition from opponents hinders them in achieving this. The flatter multiple prize structure of contest B mitigates the competition. To sum up, different degradations of sensitivity represent different types of tournament.

One aspect of the StarCraft II tournaments, which makes it distinguishable from other tournaments, is the importance of its duration. The tournaments have developed in two distinct paths, short tournaments held over a weekend and long tournaments (called Grand tournaments) spanning beyond a months’ worth of time. For organisers the choice between the two is primarily dictated by the sponsors.

Grand tournaments last a minimum of one month and have around thirty two participants. To enter the tournament, players have to qualify by competing in separate open preliminary competitions where both professionals and amateurs can participate. Alternatively, organisers can invite players. The first round is a group stage with eight groups of four players, where after three matchups the top two players from the group progress to the second round. The second round is another group stage with four groups of four players, where again the top two players from each group progress to the next round: the quarterfinals. The quarterfinals with the eight remaining players are elimination matchups. To progress to the semi-finals, a player can't lose a matchup. The remaining two then compete in the finals for the main prize. This tournament structure will be referred to as the tournament bracket.

A matchup consist of sets just like tennis and the player who wins the most sets wins the matchup. In the first and second group rounds participants play three sets. The quarterfinals and semi-finals are five sets and the finale consists of seven sets. For future reference, when talking about a match duration, it refers to the duration of the set. Near the end of a season, the players' placement for next tournament's first round is determined through lottery. For the first round, players have one month to prepare for three opponents. For the second round, players have one week to prepare for three opponents. Thus, players know well in advance who their opponents are. Players have around one hour between matchups in rounds one and two.

Quarterfinals matchups are announced right after the second round. Players can prepare, and know who their opponents are one week before the matchup in the quarterfinals. The winner from quarterfinal one, will face the winner from quarterfinal two, and so on. Players then have one week to prepare for the semi-finals. Finally, the finals are played ten days after the semi-finals.

The weekend tournaments use the same tournament bracket as the grand tournaments. Starting with group stages in the first and second round, and ending with elimination matchups from the quarterfinals onwards. Just like grand tournaments, the first round matchups are determined through lottery at the end of the previous season, giving them around one month of preparation time. However, in weekend tournaments the next round is played almost directly after the previous round. To give an example, the first two rounds are completely played on Saturday. This gives the players about three hours' time to prepare after learning who their opponents are going to be in round two. On Sunday, the last part of the bracket is then played with one or two hours in between matchups. Thus, the big difference between grand and weekend tournaments is the amount of preparation time you have after knowing who your rival is going to be. Either one week in advance and being able to comfortably train at home, or having just two hours somewhere abroad in a convention hall.

The aspects that determine the outcome of a StarCraft II match are the mechanics and the meta game of the players. “Mechanics” refer to the physical skill of a player: how fast and accurate a player’s hand-eye coordination is with the mouse and keyboard. It is comparable to playing other sports like football. For example, the player’s skill in controlling a ball, stamina and accuracy.. Professional StarCraft II players, can reach well over 300 A.P.M. (actions per minute).

Similar to regular sports, some a better than others at this. However, at the top level, players’ mechanics are on average identical. This is why the meta game of players is the big determining factor in matches. “Meta game” stands for the tactical and strategic skill of a player. This is comparable with chess, where it is a battle of wits. However, unlike chess, players only have limited information about the moves of their opponent (akin to real warfare).

There is an option however, to get an advantage over your opponent in meta game. Every match players play for training or competition is saved as a in an online database. This database contains extensive tools with which one can dissect every move made by the players. If players know who they are facing, they can study their opponent’s habits and create a strategy to defeat them. When preparation time is long, it means the player who spends the most effort studying and training is likely to win the match. Therefore, making luck an increasingly smaller determining factor of the outcome. The game is about knowing your enemy.

And herein lies the big difference between the two types of tournaments in Starcraft II. For Grand tournaments, players have up to a couple of weeks of preparation time between matchups. Whereas for weekend tournaments, players only have a couple of hours. Therefore, the amount of preparation time determines how large of a factor luck is for the outcome of the tournaments. Hence, preparation time is a great measure for sensitivity.

This paper will examine the competition between contests, and their fight for participants within StarCraft II. The focus will be on prize structures that contests use, and their effects on participation. Additionally, the sensitivity of these contests and uncertainty of potential participants will be detrimental in outlining the whole theorem. The goal is to have an empirically supported theory on the optimal prize structures for StarCraft II contests. There are substantial gaps in the state of economic knowledge concerning StarCraft II as a sport. With this thesis I want to provide empirical evidence to contribute to the further development of Starcraft II tournaments and the growing field of E-sports.

The main research question is: "When the outcome of a StarCraft II tournament is more sensitive to the contestants effort, will the use of a flatter prize structure attract more contestants?"

The main research question is further divided into sub-questions.

- Will StarCraft II tournaments that span over a longer time period, exhibit flatter prize structures?

- Will the use of a steeper prize structure in StarCraft II tournaments that span over a short period, attract more participants, than tournaments that span over a long period?

- Do steep prize structures in StarCraft II tournaments that span over a short time period, have a stronger influence on the performance of contestants than StarCraft II tournaments that span over a long time period?

The rest of this paper is organised as follows. The second section explains on which literature the theory is based. What is more, an explanation will be given as to why this research is different from already existing literature. The third section presents the specifications of the model, and describes the data and variables used in the empirical analysis. This is where the relationship between attracting participants and chosen prize structure is shown. The fourth section gives insight into the potential of applying the theory to contests. The fifth section describes the empirical framework. The sixth, seventh and eighth sections show the data, variables and proof of the empirical analysis. The ninth and final section reports and discusses the empirical results.

2 Literature Review

There is nothing more cool than being proud of the things you love.

Sean “Day[9]” Plott

First and foremost, the article of Azmat and Möller (2009) provides a guideline for this paper. The model setup created by Azmat and Möller (2009), will be used as basis for the research into StarCraft II contests. In their article of 2009 Azmat and Möller explain how the design of a contest influences the number of participants. Moreover, the parameters that drive the optimal design of a contest are shown. Azmat and Möller argue that the combination of endogenizing participation and use of multiple contests give an explanation for the existence and use of multiple prize structures. These claims fit the e-sport StarCraft II better than most tournament theories. It is for these reasons that their research is essential in this paper. Other articles of importance in chronological order are described below.

Tullock (1980), claims that the agent who exerts the highest amount of effort is not guaranteed victory. Furthermore, throughout time it has been shown that the basic idea is applicable to many contest forms. What Tullock’s contest success model essentially comes down to, is the understanding that a positive investment, whether it is money or effort, will increase the chance of being successful. This principle, as will be showcased in the discussed articles, applies to a large number of areas. For this paper, e-sports is used. However, rent-seeking, promotion contests in firms, development contracts, and traditional sports are also wildly employed.

Glazer and Hassin (1988), describe two different contests settings in a firm which have opposite results. In the first, a multiple prize structure is found to be optimal due to the participants being symmetric and the presence of risk aversion by them. A fundamental concept is brought forth through this, the fact that agents prefer to share risk, and mitigate competition. In the second, a single prize structure is most beneficial when participants are asymmetrical. The idea is that exerting effort is a linear cost function. Therefore, a single prize is the optimal incentive to promote the highest level of effort. The presence of multiple prizes only provides an incentive for participants to exert less effort.

Ehrenberg and Bognanno (1988) highlight the effective use of sports tournaments for researching tournament models. With the use of PGA golf tour data, strong support is found that participants performance or effort is influenced by the design of contests. More precise, by the level and structure of prizes.

Berry (1993) examines the consequences of multiple prize structure. In his article “rent-seeking with multiple winners” it is demonstrated that as the number of rewarded rent seekers increase, welfare losses decrease. In other words, as there are more winners, exerted effort by participants becomes less. Some important things to note, are that the participants are symmetrical and the effort cost function is linear. The essential thing to take away from this article, is that maximizing the symmetric equilibrium for every agent in a multiple prize structure will result in lower levels of effort than when invested in a single prize structure.

Clark and Riis (1996), point out that from second prize downward Berry (1993), does not consider the effort of the remaining participants of the contest. After the determination who wins first place, exerted effort has no influence on the ranking. Which of course is odd and does not reflect well with reality. In their article of 1996 Clark and Riis advance the function, so that exerted effort has influence on every prize from first to last.

Clark and Riis (1998b) expand on their article of 1996 in order to make it more broad. They maintain that single prize structure is optimal for contests when the contest has symmetric participants, simultaneous effort choosing, and the aim is to have the highest possible effort total. Interesting are the two points where a symmetric equilibrium cannot occur. The first situation is when competition is extremely high. The second situation occurs when the multiple prizes are not all equal or don’t have a linearly decreasing order to them.

Barut and Kovenock (1998), suggest that for multiple prize structure designed contests, all equilibriums must be considered. In this study, the participants are symmetrical, risk neutral and the effort cost function is linear. By giving a complete characterization of all the all-pay auction Nash equilibriums for the precise expected generated revenue, they expand on previous research for all-pay auction with n-players. Showing that every potential equilibrium sums up to the same amount of total effort, and that effort hinges on the difference between prizes not the number of them. Thus, supporting single prizes as optimal.

Krishna and Morgan (1998) put forward that when agents are risk averse and symmetric, a case can be made for multiple prizes. However, on the disposition that the amount of contestants is small. Furthermore, they discuss the issue what constitutes a winner-takes-all contest design. The argument is made that when it is solely about a single prize structure where the top half wins a reward, and first place receives more compensation than last, the winner-takes-all is then indeed optimal. However, when the additional assumption is made that the agent who exerts the highest effort wins first place, their findings do not deem a winner-takes-all as optimal.

Moldovanu and Sela (2001), provide in many ways some essential concepts for this paper. Their study focused on contests with non-identical multiple prize structure rewards for risk neutral participants. They found that the participant who exerts the most effort wins the first prize. The second prize is awarded to the next highest performance and so on, in descending order from first to last. If the cost function is convex, multiple positive prizes are optimal. In case the cost function is linear or concave for effort, a single prize structure is optimal. The results of the article suggest that as the number of participants increases, multiple rewards seem preferable. This is very much in line with other articles' perception about mitigating competition, and sharing or spreading risk.

Szymanski and Valletti (2004), make the case for the importance of optimizing second prizes in contest design. In a small contest they show how a second prize can give an incentive for participants to exert more effort. What is more, it can be essential for realising the optimal level of effort. Finally, optimization of second prizes is shown to be beneficial for increasing competitiveness: something that is a main goal of any sports contest organizer.

Cohen and Sela (2008), demonstrated that under certain dispositions, a multiple prize structure of two prizes can be preferred over a single prize structure when maximizing total effort. The situation is a asymmetric all-pay auction, with two objects who are different in value, and where the agents preferences are public knowledge. To sum up, a complete information game where the cost function of effort is linear.

Their article can be divided into two sections. First section, describes how they compared a single prize contest and a multiple prize structure contest. Their goal, is to determine which contest provides the largest sum of exerted effort by participants. They come to the same conclusion as Barut and Kovenock (1998): every potential equilibrium sums up to the same amount of total effort, and effort hinges on the difference between prizes, not the number of them. However, instead of suggesting that multiple prizes are irrelevant because of this, the claim is made that by increasing the value of the second prize, participants who do not finish first have an incentive to exert more effort. As a result, the sum of total effort increases. The loss of effort by the first placed agent is counteracted by the increase in effort of the other agents. In the second section, the relationship between contest design and chance of winning for every participant is described.

Freeman and Gelber (2009), observe the result of experimental data about solving mazes. In their experiment they have three contests. Firstly, a contest with zero sensitivity where rewards are random, independent of performance. Secondly, a contest with a single prize structure where only the highest performance receives a reward. Lastly, a contest with multiple prizes, and rewards are awarded from highest performance to lowest in descending order. The fewest mazes were solved in the contest with zero sensitivity. A higher number of mazes was solved in the contest with a single prize structure. The highest amount of mazes was solved in the contest with multiple prizes. Then the game was altered to be a complete information game. In other words, participants were informed about the number of mazes they and their rivals solved. The previous results became even more significant. Sabotage also became more apparent, reaching a high point in the contest with multiple prizes. Which is a logical consequence, when participants perceive higher payoffs to be obtainable.

The tournament theory in a firm setting, about what drives employees to exert effort, is surprisingly insightful for understanding the sensitivity parameter of Azmat and Möller (2009). Lazear and Rosen (1981) observe the compensation structure of a firm where the employees are ranked in order of performance. They constructed a simple moral hazard model of two workers that functions as a rank-order tournament which allows for finding an optimal labour contract. Holmstron (1982), Green and Stokey (1983), Nalebuff and Stiglitz (1983), Mookherjee (1984), and Bhattacharya and Guasch (1988) have generalized their model and broadened its reach in many areas. Performance is a critical part of maximizing labour equations. However, it is not sufficient to construct a contract on performance alone. Obviously, a large concern in labour tournament theory is the possibility of sabotage. In this paper and model it will be explained why this variable is of no consequence.

What makes this research different from already existing literature is, in the first place, the use of StarCraft II as source for data. To a large extent, research in the area of sports has been focused on Golf. Secondly, the variable used to measure the sensitivity or luck factor is unlike any employed before. In other research the length of a race, or the number of holes on a golf course is the measurement for sensitivity. In this research, the preparation time contestants have will determine the sensitivity. Sensitivity will increase as preparation time increases. Finally, economic research on e-sports is very limited. Moreover, research for contest design on e-sports tournaments is few and far between. Which is not strange considering this area is relatively new and the industry is young. Nevertheless, in a society where electronic games have grown to be a large source of entertainment and generations are influenced by them, it seem only right to have more economic research on the subject from a variety of angles.

3 The model

StarCraft is like a logic puzzle and art, all in one. I see beauty in it and I want to understand it more.

Daniel "Artosis" Stemkoski

The model used in this thesis is the contest model designed by Azmat and Möller. It is a model about participants' incentives for tournaments. The game consist of two contests, $i \in \{1,2\}$, and a set of participants $N = \{1,2,\ldots.n\}$, with N ≥ 3 as a minimum. The amount of effort exerted by each participant is considered a cost for those participants. The contests will both choose a specific vector of real non-negative numbers for their chosen prize structure. Let v_i = $(v_i^1, v_i^2, \ldots., v_i^n)$ denote a vector of prize structures for i contests where v_i^m is (weakly) decreasing in m, with v_i^1 being the largest, and $\sum_{m=1}^{N} v_i^m$ = 1. The value of the prize contest i awards for m has $v_i^m V$ as value. This model focuses on the effects of prize structures on player participation. The following assumptions are made: contests are mutually exclusive and players are interchangeable, risk neutral, don't pay to enter the contest, and use a linear cost function for effort. If nature would randomly choose the set of participants, according to these assumptions, the complete prize budget would be awarded to the first prize winner.

When a player competes in contests i he uses e_n ≥ 0 effort and wins prize m. The payoff is $U_n^i = v_i^m V - C_{e_n}$. The parameter C > 0 represents the participants constant marginal cost of effort. Under the assumption that players have no alternative, this can be normalized, without a loss of generality, by setting $V = C = 1$.

The game plays out as follows. Firstly, contests simultaneously choose a prize structure. They know their structure and send a message to the players. Secondly, the players simultaneously pick one contest to participate in. Finally, players observe the amount of opponents, update their beliefs based on this knowledge, and choose their effort level.

The probabilities of players winning prizes are denoted as follows. For the probability that player $n \in Y_i$ wins first prize v_i^1, given Y_i as the set of participants and N_i is the cardinality for contest i:

(1) $$P_n^1 = \frac{(e_n)^s}{\sum_{k \epsilon Y_i}(e_k)^s}$$

For the probability that player n wins the second prize v_i^2, when player m wins first prize:

(2) $$P_{n|m}^2 = \frac{(e_n)^s}{\sum_{k \epsilon Y_i - \{m\}}(e_k)^s}$$

Accordingly, the probability that player n wins the second prize is:

(3) $$P_n^2 = \sum_{m \in Y_i - \{n\}} P_m^1 P_{n|m}^2$$

In other words, the chance of winning higher prizes for a player depends both on his, and his rivals' effort. The outcome is positively influenced by the player's effort, and negatively influenced by his rivals' effort. The parameter $s > 0$ stands for sensitivity of contest i , which is the same for both players. Sensitivity is the measure to which a contest outcome is determined by the efforts of participants, also known as the luck factor. When $s \rightarrow 0$, the result of a contest is not influenced by the effort of participants. On the other side of the spectrum, when $s \rightarrow \infty$, the outcome is exclusively determined by the exerted effort of players. All luck is removed from this equation, and the player with the highest effort wins first prize, followed by the second highest in descending order.

3.1 Picking the contest

In order to show that sensitivity influences a player's choice of contest, consider the following model where players can choose between two contests with different prize structures. The prize structures are represented as v_1 and v_2, with the probability $q^*(v_1, v_2)$ that players enter contest one. First, players update their beliefs and pick the amount of effort to exert. The expected payoff for a player when entering contest one or two, under the assumption that each player enters either contest with the same probability, is:

(4) $$E[U_n^1] = \sum_{m=1}^{N} \binom{N-1}{m-1} q^{m-1}(1-q)^{N-m}\, E[U_n^1|m]|$$

(5) $$E[U_n^2] = \sum_{m=1}^{N} \binom{N-1}{m-1} (1-q)^{m-1} q^{N-m}\, E[U_n^2|m]|$$

Inserting formula (4) and (5) in to equation (6) gives the one of a kind solution $q^*(v_1, v_2)$.This is the equilibrium probability.

(6) $$\Delta(q) \equiv E[U_n^1] - E[U_n^2] = 0$$

This result makes it reasonable to expect that, when supplementing the sensitivity parameter, the outcome of the equation shifts. More concretely, participants prefer a flatter prize structure when sensitivity increases. In the following sections, these findings are expanded step by step, to create a broader model.

Let's first consider the following simple model with two contests to give some extra insight. The number of players in the model is $N = 3$. Contest A uses single prize structure $v_1 = (1,0,0)$, and contest B uses multiple prizes $v_2 = (k, 1-k, 0)$ with $k \in [\frac{1}{2}, 1)$. Sensitivity is $s = 0$. The expected payoff when more than one player enters the contest is $\frac{1}{N_i}$ and probability is q.

(7) $$E[U_n^1] = (1-q)^2 \cdot 1 + 2q(1-q) \cdot \frac{1}{2} + q^2 \cdot \frac{1}{3}$$

Is the expected payoff for every participant when entering contest A.

(8) $$E[U_n^2] = q^2 \cdot k + 2q(1-q) \cdot \frac{1}{2} + (1-q)^2 \cdot \frac{1}{3}$$

Is the expected payoff for every participant when entering contest B.

Assume $q = \frac{1}{2}$ so that both contests have an equal amount of participants, and $E[U_n^1] > E[U_n^2]$ occurs. Consequently, contest A has a larger amount of contestants in equilibrium $q^* = \frac{2-\sqrt{6k-2}}{3(1-k)} > \frac{1}{2}$ than contest B

For the opposite situation where $s = \infty$.

(9) $$E[U_n^1] = (1-q)^2 \cdot 1$$

Represents the expected payoff for a player when competing in contest A.

(10) $$E[U_n^2] = q^2 \cdot k + 2q(1-q) \cdot (1-k)$$

Shows the expected payoff for a player when entering contest B.

Using the probability $q = \frac{1}{2}$, the outcome in this case is $E[U_n^1] = \frac{1}{4} < \frac{2-k}{4} = E[U_n^2]$. This is the complete opposite of the previous case. The equilibrium is therefore $q^* = \frac{2-k-\sqrt{1-k+k^2}}{3(1-k)} < \frac{1}{2}$, and the amount of participants increases as the prize structure becomes flatter. This demonstrates the significance of sensitivity for the interaction between prize structure and participation.

3.2 The conditions of the model

In light of these findings, it is reasonable to expect that participants prefer a contest with a single prize structure when sensitivity is low. What is more, participants prefer a contest with a multi prize structure if sensitivity is high. However, as with any model, there are conditions that need to be upheld. With the support of smaller results, these conditions will be laid out.

Expected result 1: *Contests where exerted effort by players has sufficiently small influence on the outcome, will have a larger participation rate when using a single prize structure. In other words, contests with low sensitivity can maximize participation with a "winner takes all" rewards system.*

Uncertainty affects a player's behaviour and reaction to situations. When there are fewer participants than there are prize rewards, a portion of the total sum will be retained by the contest. This possible outcome is something players want to avoid. Therefore, choosing a single prize structure tournament is optimal for them. There are, of course, underling conditions that need to be met. First off, sensitivity must be sufficiently small, almost approaching zero. Secondly, there has to be more than one contest from which participants can choose. If there is only one contest, the option of choice becomes obsolete and risk neutral players in turn will have no preference towards either prize structure. The equation with sensitivity $s \to 0$, prize range $v_i^1, \dots . v_i^{N_i}$, and the expected payoff $n \in Y_i$ is:

(11) $$\lim_{s \to 0} E\left[U_n^i \middle| N_i\right] = \bar{v}_i(N_i)$$

(12) $$\bar{v}_i(m) = \frac{1}{m} \sum_{m'=1}^{m} v_i^{m'}$$

In formula twelve m stands for the sample range of which the average is taken, in order to calculate the average of the highest prizes in that contest. Just like before, $q^*(v_1, v_2)$ is a one of a kind symmetric equilibrium which occurs when the contest $i \in \{1,2\}$ has the prize structure $v_i \neq (\frac{1}{N}, \frac{1}{N}, \dots, \frac{1}{N})$. If $P^0(v_i) > P^0(v_j)$, with $P^0(v) \equiv \sum_{m=1}^{N} \binom{N-1}{m-1} \bar{v}(m)$ holds, then contest i will attract more participants than contest j. Hence, a single prize structure will be optimal.[2]

[2] See the appendix for proof

Expected result 2: When the sensitivity of a contest is high, implementing a single prize structure will attract the least amount of participants in comparison with any other reward structure.

The moment sensitivity approaches infinity, a tremendous amount of uncertainty is taken away. Players are aware that the participant with the highest effort will win the largest prize. Therefore, players will exert effort until the cost of effort equals the prize reward. Hence, competition is extremely fierce, and players prefer it to be mitigated through multiple prize structures. After all, players don't know the number of rivals they could face.

Barut and Kovenock (1998) show the first step of modelling this. Even though their model is tailored for all-pay auctions, it works very well in this context. There are similarities in the way in which contests rank their prizes, and the way the player with the highest exerted effort wins the first prize. For example, in all-pay auctions the bidder who bids the most, wins the largest sum of goods. The parameters of this equilibrium are as follows. Sensitivity is $s \to \infty$, N_i is the number of participants, v_i^N is the expected payoff, and $v_i^1 - v_i^{N_i}$ represents the fact that the cost of effort equals the potential prize rewards for players. The equation Barut and Kovenock give for expected payoff is:

$$(13) \qquad \lim_{s\to\infty} E[U_n^i|N_i] = v_i^{N_i}$$

Continuing in the same line, $q^*(v_1, v_2) \in (0,1)$is a one of a kind symmetric equilibrium which occurs when the contest $i \in \{1,2\}$ has the prize structure $v_i \neq (\frac{1}{N}, \frac{1}{N}, \ldots, \frac{1}{N})$. If $P^\infty(v_i) > P^\infty(v_j)$ with $P^\infty(v) \equiv \sum_{m=1}^{N} \binom{N-1}{m-1} v^m$ holds, then contest i will attract more participants than contest j. Thus, a multiple prize structure is optimal.[3]

[3] See the proof in the appendix

Expected result 3: Contests will attract more participants with a single prize structure compared to a multiple prize structure, when sensitivity is $s < \bar{s}$ for the contest. Furthermore, the sensitivity threshold $\bar{s}$ decreases as the number of potential participants increases. When $s > \bar{s}$, contests with a multiple prize structure attract more participants than any other contest.

Consider N the amount of potential participants who have to choose which contest to enter, where each contest uses a different prize structure. The first type of contest consists of a "winner takes all" system, preferred by participants when they are uncertain about the number of rivals, and sensitivity is sufficiently low. The second type has a multiple prize structure, also preferred by participants when they are uncertain about the number of rivals, but when sensitivity is sufficiently high. By using only two contests, it's easy to see the relationship between the amount of potential participants and the sensitivity threshold $\bar{s}$. The effort cost function used for this is:

(14) $$\max_{e_n \geq 0}[P_n^1(e_n, e_{-n})v_i^1 + P_n^2(e_n, e_{-n})(1 - v_i^1) - e_n]$$

With $0 < s < \infty$, $N_i \geq 2$, $v_i = (v_i^1, 1 - v_i^1, 0, \dots, 0)$, $v_1^1 > v_2^1$, and $i = 1{,}2$. The probability with which participants enter each contest is $q^*(v_1, v_2) \in (0{,}1)$. When effort e_n is filled in, the equation can be solved to find the symmetric pure strategy equilibrium. The first order condition is derived through substituting $e_n = e^*$. When substituted for all $n \in N_i$, it results in:

(15) $$e^* = \frac{s}{N_i}\left(\frac{N_i - 1}{N_i} - \frac{1 - v_i^1}{N_i - 1}\right)$$

If e^* equals formula (15), and $s \leq \frac{N}{N-1}$, then the following equilibrium will occur:

(16) $$E\left[U_n^i \middle| N_i\right] = \frac{1}{N_i}\left(1 - s\left(\frac{N_i - 1}{N_i} - \frac{1 - v_i^1}{N_i - 1}\right)\right)$$

The threshold $\bar{s}$ is:

(17) $$\bar{s} \equiv \left(\sum_{m=1}^{N-1} \frac{\binom{N-1}{m}}{m(m+1)}\right)^{-1} \in (0{,}1)$$

This shows that when the number of participants increases, the sensitivity threshold becomes smaller. Which is in line with the importance of uncertainty about the number of potential participants in relation to the preference of players for multiple prize structures on the basis of mitigating competition. Interestingly, when the number of rival participants is set towards infinity, the sensitivity threshold will approach zero. Thus, only a fraction of sensitivity is needed for a contest to ensure that multiple prize structures is the best option.[4]

[4] See the appendix for proof

4 Optimal prize structures

More GG, more skill.

Aleksey “White-Ra” Krupnyk

Sponsorships in sports are a big business. In 2002 year-over-year growth was reported at 3,7%, with numerous companies spending more than $100 million each year. Total projected sponsorships in 2003 for the U.S. alone came to $10.52 billion, 69% of which allocated to sports. Now more than ten years later, IEG[5] reports a year-over-year growth of 5,5% for North American companies, and 4,2% globally. For 2013, the total projected sponsorships in the U.S. are $19.94 billion. On a global scale, the total expenditure on sponsorships is projected at $53.3 billion, and again 69% of the pie will go to sports with entertainment trailing at 10%, charity at 9%, arts at 5%, festivals at 4%, and membership organizations at 3%. Even in this economic volatility, the growth of long term corporate sponsorship keeps increasing.

The numbers and the growth in sponsorship illustrate the remarkable belief in sponsoring from companies. Any company or product that wants exposure, and aims to build loyalty with its target audience, uses sponsoring in some shape or form to achieve this. It is the most sought-after solution in marketing communications. Sport industries in search of corporate sponsorships can expect large funds, and tremendous commitment that undoubtedly will propel the sport to new levels. However, like with all things in life, the knife cuts both ways. Companies have raised the standards required to enter these lucrative partnerships. Beneficiaries need to offer more than just publicity or the right to print a slogan. What companies want are large rights holders that have major media channels, ready to be part of the partnership. They also demand that the sport has national, or more preferably, international awareness with a large audience, and an extreme high level of prestige.

[5] http://www.sponsorship.com/iegsr

The premise of all this is of course the vision of sports entertainment. Getting interested into professional gaming, and e-sports starts with the players. When mainstream media turns its attention to e-sports and make a report about the industry, they always discuss the players of these games. Usually the focus is on the youth of the player and the prize money they acquire during gaming tournaments. Those elements are easy to understand and communicated to the public. It provides a human touch to an alien subject for many. As with all sports industries, the professional players are extremely important. When asked to recall all the basic rules, tactics, and strategies of as many sports as possible, only a few people will be able to recite more than three. Yet, when asked to name top players from as many sports as possible, the amount mentioned will undoubtedly be much greater. Professional gamers are the logical way to understand the story since they personalize the activity, providing the public with an embodied picture of high level competitive gaming. Competitive play by these professionals with all its intensity, commitment, and drama is captivating and enticing. This is what breaks boundaries, and kindles interest in computer games and those who play them.

It is for all these reasons, that participation is of fundamental importance to organizers of StarCraft II tournaments. As the amount of participants increases, so do the personal stories they bring with them, and the potential audience that is reached. It secures the prestige demanded by sponsorships, and provides them with contacts needed to reach the communities. Each tournament organiser therefore exhausts each and every option to get the largest quantity of high quality participants. The sport does not just start with players, it is the key for its growth.

These facts were recently confirmed in a Q&A[6] by Kim Phan, Senior e-sports Manager at Blizzard Entertainment. Kim Phan says it’s their goal to increase the viewership and the community of StarCraft II, to create storylines for professional competitions, to identify the top players in the world, and to make the tournament format more linear and easier to follow.

[6] http://www.teamliquid.net/forum/viewmessage.php?topic_id=432243

Expected result 4: *Organizers of contests want to optimize the amount of participants that enter their competition, by taking sensitivity and number of potential participants into account. Organizers pick the prize structure that gets them the largest amount of participants.*

First off, let's consider the situation where sensitivity is sufficiently small and there are two types of contests. Contest A where $Nq^*(v_1, v_2)$ is maximized with v_1, and contest B where $N(1 - q^*(v_1, v_2))$ is maximized with v_2. The optimal prize structure for each contest to attract the largest sum of participants is that of $v_1^* = v_2^* = (1,0, \ldots ,0)$, a single prize system.

Secondly, consider the case where sensitivity is sufficiently large. The optimal strategy for these contests is to have $N^* = \frac{N+1}{2}$ prizes, when there is an odd number of potential participants. If there is an even number of potential participants, it is optimal to have $N^* = \frac{N+2}{2}$ prizes. In both situations the prizes are equally large.

To give an example, say there are ten potential participants for a contest, and sensitivity is sufficiently large. Ten is an even number. Therefore, the optimal amount of prizes the contest should have is six: $N^* = \frac{N+2}{2} = 6$ (when entering 10 for N). However, remember that participants want to mitigate competition. The contest that mitigates competition the best is the contest with the largest sixth prize. If maximized, this would lead to six equally large prizes.

Thirdly, suppose the potential participants amounts to six or more, and the contests can only award three prizes. The prize structure that is used in the equilibrium, is $v_1^* = v_2^* = (1,0, \ldots ,0)$, if $s \in (0, \bar{s})$. In case $s \in (\bar{s}, \bar{\bar{s}})$ the prize structure that is used in equilibrium is $v_1^* = v_2^* = \left(\frac{1}{2}, \frac{1}{2}, 0, \ldots ,0\right)$. When $s \in \left(\bar{\bar{s}}, \frac{N}{N-1}\right)$, the optimal prize structure in equilibrium is $v_1^* = v_2^* = (\frac{1}{3}, \frac{1}{3}, \frac{1}{3}, 0, \ldots ,0)$. With the following assumptions $\bar{s} \equiv \left(\sum_{m=1}^{N-1} \frac{\binom{N-1}{m}}{m(m+1)}\right)^{-1} \in (0,1)$, $0 < \bar{s} < \bar{\bar{s}} < 1$, and:

$$(18) \qquad \bar{\bar{s}} = \frac{N-1}{2}\left(\sum_{m=2}^{N-1} \frac{\binom{N-1}{m}}{(m-1)(m+1)} - \frac{N-1}{4}\right)^{-1} > \bar{s}\,.$$

Finally, if sensitivity does not equal zero, and effort has an ever so small influence on the outcome of a contest, then it is optimal for a contest to use a multiple prize system, when the number of potential participant is also sufficiently large. Interestingly, not only does the number of prizes increase with sensitivity, the prize structure itself becomes flatter.[7]

[7] See the appendix for proof

5 Empirical framework

A gamer's keyboard is like his sword, and his mouse is like his …. other sword.

Sean "Day[9]" Plott

In this section, the data and chosen variables of the empirical tests will be discussed. The data is collected from over a hundred premier StarCraft II tournaments. There is more data available from other tournaments. However, those are held on a semi-professional or even amateur level. As a result, the data from those tournaments does not provide any additional explanatory power. Therefore only premier tournaments are used, which feature an exclusively professional competition. StarCraft II is leading the charge for the e-sport scene; a branch of video gaming where people compete with each other for monetary rewards. The video game industry is a fast growing industry, with a reported revenue of over $66 billion in 2011. Every year new record sales are set, recently (September 2013) a game called "Grand Theft Auto V" made more than $800 million on the first day of its release. The common denominator is competitive online gameplay, and StarCraft II is the standard all others are measured with.

The data is a great indicator, for how an important branch of a worldwide multi-billion dollar industry is progressing. Additionally, due to the way StarCraft II premier tournaments are set up, they lend themselves very well for empirical testing.

In the first place, contestants compete in an extremely controlled environment. Players sit in soundproof pods with tinted windows and air-conditioning. The players are completely isolated from the outside for the duration of the match. The matches themselves are played on a supplied PC, players only have to bring their own mouse and keyboard. Cheating or sabotage is practically impossible, because the matches are played over a network controlled by the organizer. If a player attempted to hack the game, in order to get an unfair advantage in the match, it would be noticed immediately.

Secondly, the outcome of a tournament is ranked from first to last, with extensive details and information about each and every match. The results are simple and straightforward: you either win or lose a match, and there are no ties or complicated point systems.

Third, the tournament organizers function much like individual firms. With Activision Blizzard acting as a government that hands out licenses. The guidelines for tournaments are quintessential free market with two major demands: that content is for all ages and viewers are free of charge.

Fourthly, the last major demand plays into sponsoring as, is intended by Blizzard. Furthermore, tournaments are very identical. This is stimulated by the competition between the organizers. When one tournament has success with a certain formula or setup, others will quickly follow suit and attempt to improve upon it.

Finally, participation is pivotal, since it accommodates the sponsorships and attracts the largest number of viewers. Having the best players in the world competing and showcasing the highest level of matches, is the way these tournament organisers create revenue. On a side note, unlike many regular sports, participation is more important than effort for the organisers. Where others promote through the records that are being set, StarCraft II and e-sports in general focus on the matchups between contestants, and who of the top players are competing.

5.1 Measuring performance

The objective of a StarCraft II match is to destroy the base of your opponent. Both players start with one building and six units. As the match progresses, more units and buildings are built in order to field a bigger and stronger army. It is reasonable to expect that the player who is more prepared for the matchup will control the superior army. However, this does not automatically lead to victory. First off, involuntarily losing a match is far more easy than winning one. Secondly, bases are across the map from one another, creating a strong defender's advantage. This means, that the defending player can resupply his army quicker and safer than the attacker. Due to these mechanics of the game every player follows the same basic mantra of "When ahead, get more ahead".

If player A is more prepared than player B, it is optimal for player A to play a safe game with minimal chance of losing. After a few minutes, the first engagement between players occurs, player A wins, and now has a small army size advantage. A couple of minutes later, a second engagement occurs. Player A wins again due to his larger army and now controls the map. As a result, player A acquires access to superior resources on the map. The army of player A is larger, stronger, and grows faster than his opponent's. Quickly thereafter, player A lays siege to Player B's base, player B starves for resources, loses the arms race and defeat is imminent. The safest way to win, is by accumulating small victories that chain into each other.

Player B is aware of this sequence. When player B hasn't prepared well by training and studying hard, a long lasting match will not be optimal for him. An increase in match duration decreases his chance of winning. As a result, player B will attempt a high-risk-high-reward strategy only a few minutes into the game. If his opponent has trained and studied well, the chances of player B losing the first engagement are very high. Which brings us back to the sequence described above. If the opponent of player B hasn't prepared well for the matchup, then chances are that the high-risk-high-reward strategy will pay off for player B, giving him a quick win. In case both players are strong and well prepared for the matchup, neither has an incentive to engage the opponent quickly. Matches can be as short as four minutes or take as long as three hours. For that reason, performance is measured as increasing in the duration of the match.

6 Data

It's not about playing the perfect game, it's about winning.

Nick "Tasteless" Plott

The empirical tests of this research draws its data from the primary source of information on StarCraft II: teamliquid's liquipedia. This is an online database, which contains the data of each StarCraft II tournament ever organised. Some examples of the data that can be found here is: name, location, tournament brackets, total prize pool, prize structure, duration of tournament, average match duration per tournament, match statistics, world ranking of players for each season, video replay links, and biographies of organisers and professional gamers. Both men and women compete in the same tournaments, though the men significantly outnumber the women.

Additional sources of data are the websites of the tournament organisers. Since tournament may not be broadcasted on television, matches are broadcasted online through live streams on these websites. They also feature fully archived footage of past tournaments. These sources have been used for the retrieval and checking of average match duration statistics.

The players are ranked according to a point system which is identical to tennis. Ranking higher in tournaments earn players more points. There are two important things to note here. First, the ranking system only comes into play for one tournament each year and that is the World Championship Series Grand finales. All other tournaments during the year have their own qualification system, which consists of invitations and/or preliminary rounds. Secondly, the liquidpedia database shows when and in which tournament players have earned points. This makes it possible to see the exact ranking of the players before, during, and after a specific tournament. This is important information to compare the ranking of participants between tournaments.

As explained before, StarCraft II tournaments have developed in two types: grand tournaments and weekend tournaments. Grand tournaments take at least one month, weekend tournaments last a maximum of five days. Weekend tournaments are usually tied to some form of technology convention like the Intel convention at CeBIT in Hanover, because it has great synergy with the sponsors. The tournament usually lasts as long as the convention, between two and five days, with the most important part of the tournament bracket always on Saturday and Sunday. The grand tournaments last at least one month, with matches being played during the week. The organisers aim for exposure by providing a constant steam of content, which does not need to compete with the weekend tournaments.

For an organizer, the choice between a grand tournament or a weekend tournament comes down to the sponsorship. Beggars can't be choosers and organising a tournament is not easy. Working together with technology conventions and capitalising on already existing sponsor relations is a logical approach. The presence of an e-sports tournament creates more publicity for the sponsors, and purposefully letting it peak in the weekend will ensure the highest attendance possible, for both tournament and convention.

The grand tournaments are all collaborations between Activision Blizzard and organisers, both are at the same time also a sponsor. For example, GomTv, a Korean internet streaming service and part of the large software company Gretech Corporation, is a grand tournament organiser. Showcasing e-sports tournaments through their own streaming service has obvious advantages. On the one hand, they have more freedom to pick and choose the duration of a tournament than the organisers of weekend tournaments. On the other hand, those same weekend tournaments dictated the issue of tournament duration. Because GomTv doesn't want their tournament to overlap with the weekend tournaments. Unlike the weekend tournaments, their revenue depends more heavily on internet stream viewers. Also, Activision Blizzard wants continuous exposure, driving the issue of delivering StarCraft II content over a long time and during the week even further. As a consequence, the duration of tournaments greatly depends on what is in the best interest of the sponsorships.

7 Analysis

If you start procrastinating there is no question who the loser will be.

Lim "Nestea" Jae Duk

In part four of the model, the case is made that if a tournament has a short preparation time, choosing a steeper prize structure is optimal. Whereas a flatter prize structure is optimal if the tournament has a long preparation time.

To sum up *(1): Tournaments of StarCraft II that span over a long time period will use flatter prize structures*.

From part three of the model, it is expected that as sensitivity decreases, potential participants increasingly prefer contests with steeper prize structures. On the other hand, when sensitivity increases a flatter prize structure becomes more attractive for participants.

Therefore, it seems reasonable to expect that *(2): Using flatter prize structures will be more attractive for contestants in tournaments that span over a long time period than tournaments that span over a short time period.*

The model shows that sensitivity, participation, and prize structure determine the effort and preferences of players. When taking sensitivity out of the equation, the theory becomes simple and straightforward. It suggests that performance increases with steepness of the prize structure, since sensitivity (which is measured by preparation time) influences participation.

The following seems feasible *(3: Steep prize structures will have a stronger influence on the effort of contestants in tournaments that span over a short time period compared to those that span over a long time period.*

Azmat and Möller (2009) are the guide for this research. Their completeness of modelling, testing the incentive effects of prize levels and prize spread, has proven to be very hard to argue with. They are not alone. Ehrenberg and Bognanno (1990 a,b), Maloney and McCormick (2000), and Lynch and Zax (2000) all provide very insightful research. At times, the results of this research have an resemblance to the outcomes of Azmat and Möller (2009). However, where the others find that steeper prizes and the total prize pool primarily influence performance, the results of this research suggest that sensitivity has a greater role than either on performance.

Descriptive Statistics
Weekend Tournament

	N	Minimum	Maximum	Mean	Std. Deviation
Measure of steepness 1:total	76	0.20440252	0.75	0.40	0.107
Total prize pool	76	$4000.-	$250,000.-	$47,322.-	$47,691.-
Number of available seats	76	10.00	128.00	39.03	29.76
Number of prizes	75	3.00	32.00	13.45	7.57
Duration in days	75	2	6	3.29	0.983
Average match duration	71	10:01	23:01	17:17	03:28
Top four participants	70	6.00	98.50	45.04	22.42

Descriptive Statistics
Grand Tournament

	N	Minimum	Maximum	Mean	Std. Deviation
Measure of steepness 1:total	47	0.11565217	0.625	0.32	0.130
Total prize pool	44	$1930.-	$188,120.-	$91,437.-	$53,899.-
Number of available seats	44	16.00	64.00	35.09	10.85
Number of prizes	44	4.00	64.00	30.00	13.09
Duration in days	43	25	102	49.81	19.816
Average match duration	44	11:12	23:08	18:59	03:12
Top four participants	40	5.00	81.00	20.07	16.89

Expectation 1: Tournaments of StarCraft II that span over a long time period will use flatter prize structures

The data shows a negative relation between steepness of the prize structure, and tournament duration. For example, the season III competition of North-America lasted forty eight days, and awarded 20% of its total prize pool to the winner. In comparison, the IEM tournament of New York lasted four days, and awarded 40% of its total prize pool to the winner. Both tournaments were held in the fall of 2013. Using data from one hundred and nineteen tournaments of the past four years, the influence of tournament duration on prize structure steepness is tested through the following formula:

(19) $$Y_i = \alpha + \beta D_i + \varepsilon_i$$

The steepness of the prize structure is the dependent variable represented as Y_i in this equation. Tournament duration is represented as the coefficient D_i, with duration measured in days. The shortest tournament duration is two days, and the longest is one hundred and two days.

Different measures of steepness are used. The first is C.I., a concentration index similar to the Hefrindahl-Hirschman index, and the C.I. used by Azmat and Möller. In this case, with the adjustment of using the top four prizes instead of the top three prizes, because places three and four are considered to have the same rank. Hence, the formula for C.I. is $Y_i = \frac{(1st)^2(2nd)^2(3rd)^2(4th)^2}{(1st+2nd+3rd+4th)^2}$. The second measure is the ratio between first and second prize. The third measure used is the ratio between first and third prize. Finally, the ratio between the first prize and the total prize pool is used. The expectation is that when tournament duration increases, the forenamed ratios decrease.

Next to having sensitivity measured as time in days, tournaments are separated into two categories. This makes a lot of sense because of the two clear paths tournaments have developed in. As a result, a discrete comparison between grand and weekend tournaments is made. This allows for interpreting the change in steepness when moving from one category to the other.

The results can be seen in panel A and B for all four measures of steepness. Panel A shows the influence of time in days without controlling for any other factors in the first four columns. The ratio between the first prize and total prize pool is significant at the 99% interval. For every day a tournament increase in duration, the prize structure becomes 0,1% flatter. A lower ratio of first prize to total prize pool means that less money is given to the winner, relative to all the other participants together. Therefore, a lower ratio also entails that the quantity of prizes increases with every day a tournament lasts longer. If an average weekend tournament would increase its duration with forty-five days, the average duration of a grand tournament, The first place winner would hand in over $2100,- from its previous winnings of $19.000,-. For comparison, the federal U.S.A. tax cut[8] as of 2013 of a $19.000,- income is $2850,-.

Panel A		Measure of prize structure steepness							
	Dep Var	C.I.	1:2	1:3	1:total	C.I.	1:2	1:3	1:total
Time in days	Coefficient	0.000	0.000	0.000	-0.001	0.000	0.001	0.001	-0.002
	Std. Error	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.000
	Sig.	0.519	0.819	0.352	0.001	0.336	0.099	0.117	0.000
Constant	Coefficient	0.366	0.503	0.275	0.397	0.342	0.544	0.332	0.394
	Std. Error	0.008	0.012	0.013	0.014	0.010	0.014	0.014	0.017
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total prize	Coefficient					0.000	0.000	0.000	0.000
	Std. Error					0.000	0.000	0.000	0.000
	Sig.					0.000	0.000	0.000	0.829
Observations		119	119	119	119	119	119	119	119

In panel B, the example above is properly tested. It shows the change in steepness when moving from a weekend tournament to a grand tournament. The ratio between first prize and total prize pool is 9% flatter, and again significant at the 99% interval. Suggesting that first place would in fact hand in over $4200,-. The number of rewards will double at the same time. Furthermore, it supports the predictions for the relationship between tournament duration and prize structure.

[8] http://www.irs.gov

Panel B		Measure of prize structure steepness							
	Dep Var	C.I.	1:2	1:3	1:total	C.I.	1:2	1:3	1:total
Grand Tournament	Coefficient	0.018	-0.012	-0.024	-0.090	-0.002	0.024	0.025	-0.094
	Std. Error	0.013	0.020	0.021	0.022	0.014	0.020	0.020	0.024
	Sig.	0.173	0.551	0.254	0.000	0.898	0.228	0.200	0.000
Constant	Coefficient	0.363	0.506	0.276	0.399	0.340	0.546	0.334	0.395
	Std. Error	0.008	0.012	0.013	0.013	0.010	0.014	0.014	0.017
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total prize	Coefficient					0.000	0.000	0.000	0.000
	Std. Error					0.000	0.000	0.000	0.000
	Sig.					0.000	0.000	0.000	0.660
Observations		119	119	119	119	119	119	119	119

By using the following formula, the variables can be controlled for additional factors:

(20) $$Y_i = \alpha + \beta D_i + \delta X_i + \varepsilon_i$$

When controlling for the total prize in panel A, represented by X, the coefficient time in days remains significant, and changes to 0,2% up from 0,1%. In short, the first place winner would hand in over $4200,- instead of $2100,-, similar to the previous results of panel B. Even though the total prize pool itself has no meaningful significant coefficient, it does provide additional information.

Panel B shows tournaments will experience a 9,4% drop in steepness, when moving from a weekend to a grand tournament design, if the total prize pool is controlled. The other measures of steepness are not significant in any of the tests. The grand tournaments divide the prize pool over a far larger amount of participants than the weekend tournaments. It is only natural that the difference is more significant when using the ratio first to total prize pool, since it more accurately represents this characteristic.

Panel C		Measure of Steepness			
	Dep Var	C.I.	1:2	1:3	1:total
2012-2013	Coefficient	-0.026	0.031	-0.005	-0.045
	Std. Error	0.013	0.019	0.021	0.022
	Sig.	0.049	0.110	0.801	0.046
Constant	Coefficient	0.384	0.484	0.270	0.391
	Std. Error	0.010	0.014	0.016	0.017
	Sig.	0.000	0.000	0.000	0.000
Observations		119	119	119	119

Additionally, panel C shows the change in steepness when going from the data set 2010-2013 to the set 2012-2013. The changes in C.I. and ratio 1:total prize pool is significant. C.I. shows that the time period 2012-2013 is 2,6 % flatter compared to the whole data set. For the ratio between first and total prize pool the results suggest that the prize structures have become 4,5% flatter. The proportion of grand and weekend tournaments from the different sets is displayed in panel C*. This prompted the examination of the grand and weekend tournaments individually for the time period 2012-2013. Panel C** demonstrates the significant decrease in steepness of 10,5% for grand tournaments. Confirming that since 2012, the prize structures of grand tournaments have become flatter. Weekend tournaments on the contrary have only become 1,6% flatter since 2012. This coefficient is not significant.

Panel C*	Number of tournaments	
	2010-2013	2012-2013
Grand Tournaments	41	22
Weekend Tournaments	75	46
Ratio	0.55	0.46

Panel C**		Measure of Steepness
	Dep Var	1:total prize pool
2012-2013 Grand T.	Coefficient	-0.105
	Std. Error	0.030
	Sig.	0.001
2012-2013 Weekend T.	Coefficient	-0.016
	Std. Error	0.024
	Sig.	0.499
Constant	Coefficient	0.392
	Std. Error	0.016
	Sig.	0.000
Observations		119

The results indicate that prize structures in general have become flatter. However, when controlling for the two duration categories, only grand tournaments have become significantly flatter since 2012. This development suggest that flatter prize structures with multiple awards are superior to single prize structures for StarCraft II grand tournaments. An explanation as to why weekend tournaments on themselves do not share this result, is the fact that weekend tournaments tent to lag behind in design and production compared to grand tournaments. Grand tournaments for example were first with professional commentators, hosts, and soundproof pods.

Expectation 2: Using flatter prize structures will be more attractive for contestants in tournaments that span over a long time period than tournaments that span over a short time period

The model shows that participants prefer a flatter prize structure when a tournament has high sensitivity. Moreover, as sensitivity increases, the preferred prize structure by participants decreases in steepness. Due to sensitivity being positively dependent on tournament duration, flatter or multi prize structures should be more attractive to participants in grand tournaments.

This is tested by measuring the influence of prize structure on participation separately for the two categories, grand and weekend tournaments. Participation is measured as the average rank of the top four participants, where a lower score represents a higher ranking. With open brackets and preliminaries it becomes impossible to determine the true amount of participants for each tournament. Likewise, attracting, facilitating, and identifying top players is an official primary goal[9] of Blizzard and organisers. Therefore, this approach is a more accurate portrayal of reality. The formula used to test these assumptions empirically is:

(21) $$Part_i^D = \alpha^D + \beta Y_i^D + \delta X_i^D + \varepsilon_i^D$$

The dependent variable is the participation for a tournament within the designated category. Steepness of the prize structure is again Y, and X is the total prize pool. This setup allows to demonstrate the participation for a tournament, given the level of sensitivity.

Panel D showcases the results from this equation. The first thing that can be seen is that the steepness and the average rank of top participants have a significant negative relationship. If the prize structure of a grand tournament becomes 10% steeper, the average rank of the top four players would decrease by 4.77. This is the difference between having the top four players in the world at your tournament, or having players outside the top five and top ten at your tournament. For organisers who rely on sponsorships, this is a world of difference. Imagine having FC Barcelona and Real Madrid at your tournament, or not.

Panel D		Participation Measure	
Dep Var		Grand Tournaments	Weekend Tournaments
1: total	Coefficient	47.731	20.971
	Std. Error	23.095	24.654
	Sig.	0.046	0.398
Total prize	Coefficient	0.000	0.000
	Std. Error	0.000	0.000
	Sig.	0.049	0.090
Constant	Coefficient	15.871	41.503
	Std. Error	7.706	11.025
	Sig.	0.047	0.000
Observations		41	75

[9] http://www.teamliquid.net/forum/viewmessage.php?topic_id=432243

The total prize pool is significant, though the coefficient is extremely small and basically zero. The coefficient for weekend tournaments is smaller than that of grand tournaments, in line with the expectations. No concrete assumption can be made from these statistics as they are not significant. Nevertheless, the data reflects the expectation that an increase in steepness would have a greater negative consequence for participation in grand tournaments than it would for weekend tournaments. It must be mentioned that observations for both categories should preferably be higher. This can be attributed to the youth of the sport, because at this moment only data from 2010-2013 was available. With time more tournaments will occur, and observations can increase.

Expectation 3: Steep prize structures will have a stronger influence on the performance of contestants in tournaments that span over a short time period compared to those in tournaments that span over a long time period

The performance of participants in tournaments is measured by the average match duration of a tournament. Longer match durations indicate a higher performance by participants. When both participants are well prepared for their opponent, neither player can be surprised at the start of a match. Therefore it can be assumed that more effort is exerted by the players, and thus performance increases with match duration. The results demonstrate that match duration depends on the prize spread and participation. From the model and other research it seems feasible to assume that steeper prize structures give an incentive to exert higher levels of effort, disregarding sensitivity. Hence, indicating that a steeper prize structure in a weekend tournament with lower sensitivity will have a positive relation with match duration. This relationship should be weaker for grand tournaments. The following formula is used to examine these assumptions:

(22) $$W_i = \beta_o + \beta_1 Y_i + \beta_2 P_i + \beta_3 D_i + \varepsilon_i$$

The average match duration of tournament i is the dependent variable W_i, with time expressed in seconds. The steepness of prize structures is represent as Y_i. The total prize pool is represent by P_i, and D_i is the tournament duration categories.

Finally, to test the expectation, the previous formula is extended to test the relationship between prize structures and the two tournament duration categories. The following formula is used:

(23) $$W_i = \beta_o + \beta_1 Y_i + \beta_2 P_i + \beta_3 D_i + \sum_{D \in \{S,M,L\}} [\gamma_D (Y * D)_i + \delta_D (P * D)_i] + \varepsilon_i$$

The γ_D and δ_D are interaction terms that represent the relationship between prize structures and the two duration categories.

Panel E column (1) shows the results, and the ratio between first and total prize pool is used to measure the steepness of the prize structure. The coefficient is significant and positive, suggesting that when prize structures increase in steepness, the average match duration increases. More practically, if the prize structure becomes 10% steeper, the average match will be forty seconds longer. This is in line with the assumption, that a "winner takes all" prize structure increases performance.

The coefficient for the total prize pool indicates that for each $1000,- in prizes, average match duration increases with one second. With total prize pools spread as large as $200.000,-, money is also in the e-sports scene a good incentive for performance. The significance of 0.058 is however not as robust as preferred.

Comparing the regression coefficients of grand and weekend tournaments to the null hypothesis $H_0 : \beta_{Grand} = \beta_{weekend}$ tournament regression coefficient. With the use of a dummy, a T-value 4.640 is found with a significance of 0.000, demonstrating that the weekend regression coefficient is significantly different from the grand tournament coefficient. This means there is a significant difference in the coefficients on average match duration across the two categories for tournament duration.

Panel E column (2) shows the results for controlling the interaction between prize structures and the two categories of tournament duration. For the grand tournaments, total prize money seems to have no effect on performance. While total prize money has a significant positive effect on the 95% interval for performance in weekend tournaments.

Panel E		Average match duration	
		(1)	(2)
Ratio 1: Total	Coefficient	391.830	
	Std. Error	154.057	
	Sig.	0.012	
Total prize	Coefficient	0.001	
	Std. Error	0.000	
	Sig.	0.058	
Weekend Tournament	Coefficient	994.187	
	Std. Error	195.291	
	Sig.	0.000	
Grand Tournament	Coefficient	-208.731	
	Std. Error	227.362	
	Sig.	0.363	
Total prize Weekend T.	Coefficient		0.001
	Std. Error		0.001
	Sig.		0.032
Total prize Grand T.	Coefficient		0.000
	Std. Error		0.001
	Sig.		0.846
1: total * Weekend T.	Coefficient		1051.393
	Std. Error		194.844
	Sig.		0.000
1:total * Grand T.	Coefficient		-411.279
	Std. Error		245.423
	Sig.		0.102
Observations		119	119

If an average weekend tournament prize pool would double, the average match duration of that weekend tournament would increase by forty-seven seconds. This would make the match average of the tournament just 4% shorter than the mean match duration of grand tournaments. In other words, money can reduce the gap in performance between weekend and grand tournaments. Blizzcon, the most prestigious weekend tournament, does exactly this.

Furthermore, the panel shows the effects of the prize structure in column (2). It demonstrates that only the weekend tournament coefficient is significant. The interaction coefficients across the two categories are significantly different. In fact, the weekend tournament has a positive effect and is larger than the grand tournament coefficient, which is not significant.

To sum up the consequences of the interaction coefficients, steeper prize structures will have a positive and larger influence on performance in weekend tournaments than in grand tournaments. The direction of the grand tournament interaction coefficient is negative. If it was significant, this suggests that an increase in steepness would have a detrimental effect on performance for grand tournaments. This supports the assumption of expectation 3.

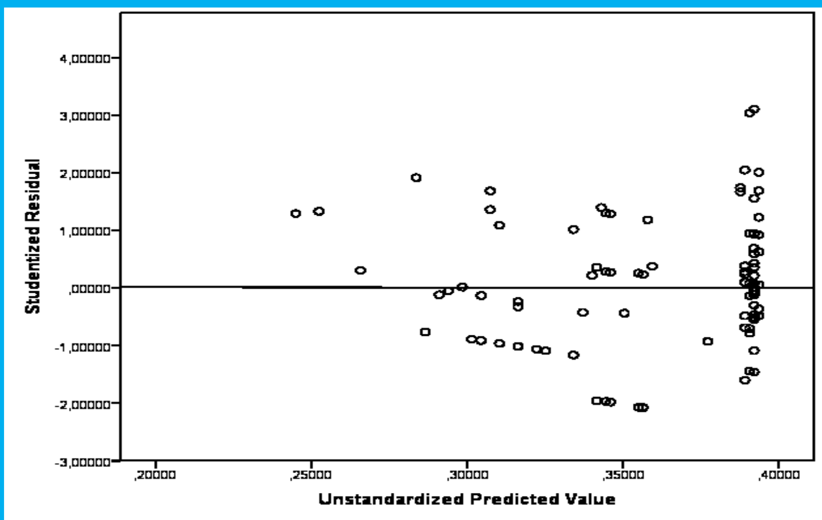
8 Robustness of the regression

I would be speechless, but I'm getting paid not to be.

Geoff "iNcontroL" Robinson

The first step is to check the validity of the regression and model with residual plots to test for biases, which is something that R^2 cannot determine. Randomness and unpredictability are crucial components of any regression model. It should not be possible to predict the error for any given observation. This translates to a residual plot where the residuals should not be either systematically high or low. To sum up, the residuals should be centred on and around zero. This guarantees a model that is correct on average for all predicted values. Residual plot one shows the correct spread. The only point of critique is the constant spread throughout the range of predicted values. With seventy observations, the low predicted values have a good representation. Whereas, for the higher predicted values there are just about forty observations. Looking at the overall symmetric pattern, this point of critique is really due to the number of observations, and not due to a bias.

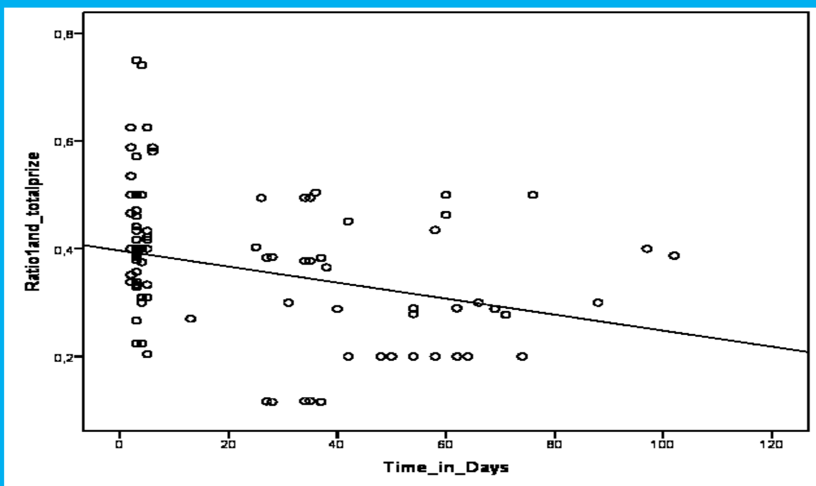
Residual Plot



Model Summary				
	R	R Square	Adjusted R Square	Std. Error
Model 1 Scatterplot	0.310	0.096	0.088	0.116

The second step is the goodness of fit of the linear model. The R^2 is 0.096 for the model, with 1:total as the dependent variable, and time in days as the independent variable. The first thing to check for with a low R^2, is whether or not the model is quadratic. The Scatterplot shows that this is not the case. The pattern is linear, although the number of observations for the higher range of independent variables demands attention.

Scatterplot



The final step is interpreting the results beyond the data. The low R^2 is not preferable, yet it is not necessarily bad or undermining the regression for several reasons. In the first place, the regression aims to predict human behaviour. This is simply harder to predict than anything else. Secondly, the predictors in the regression are significant at the highest interval level. Thus, regardless of R^2, important and valid conclusions can be drawn from the values. In the conclusion this point will be further supported. Lastly, the limited number of observations due to the youthfulness of the sport weighs heavy on the percentage of R^2, this can clearly be seen in the plots. Additionally, both the scatterplot and residual plot show promising patterns.

9 Conclusion

When you are ahead, get more ahead.

Daniel "Artosis" Semkoski

The following section concludes this study on competition amidst StarCraft II contests. The first issue that is examined is sensitivity. Sensitivity is the measure to which extent the outcome of a contest is influenced by the effort of players. The research demonstrates tournament duration to be an accurate measure for sensitivity. This study found a strong negative relationship between prize structure steepness and tournament duration. By contrast, sensitivity has a significant positive influence on the number of prizes. What is more, the ratio of first prize compared to the total prize pool decreases as sensitivity increases.

The second issue is participation. Participants are important for various reasons to contest organisers. The results indicate an increase in participation, when multiple prize structures are used by contests with sufficiently high sensitivity.

Finally, performance incentives were studied. Unsurprisingly, the size of the total prize pool is a strong trigger for performance. In short weekend tournaments, a steeper prize structure resembling a winner takes all system is also a significant motivator.

Additionally, the results point to an interesting trend of prize structures becoming significantly flatter over the past two years in general. Due to the relatively limited number of observations, this development has not been explored more extensively. The number of observations have hampered the research in some other areas as well. With time, this issue will be resolved as more data becomes available. Another point of critique is the limitation of the model concerning risk aversion. This also prevents certain research possibilities.

Future research could remove these limitations, and provide additional insight in this sports branch. The importance for this was reflected in a Q&A[10] with Kim Phan, the senior e-sports manager at Blizzard, in the fall of 2013. First off, their plan for 2014 is to stimulate an increase in breathing room for everyone, from players all the way up to organisers. In other words, increasing the duration of tournaments, resulting in more time between matchups. Surprisingly, the reason behind this from Blizzard is to stimulate more flexibility in the calendar. This paper and future research can provide insight into additional consequences that are not yet anticipated. Secondly, a large point of discussion is the prize structure and total prize pool of tournaments. Kim Phan admits that no decisions are made yet and multiple areas are being evaluated concerning this point. I am hopeful that this research, and research to come, can play a part in providing the answers needed for these questions.

[10] http://www.teamliquid.net/forum/viewmessage.php?topic_id=432243

Appendix

Proof expected result 1

The limit is $s \to 0$. Each contest will be entered by participant with $q = \frac{1}{2}$. Therefore, $\Delta\left(\frac{1}{2}\right) = \frac{1}{2^{N-1}}(P^0(v_1) - P^0(v_2))$. When $v_1 \neq (\frac{1}{N}, \frac{1}{N}, \dots, \frac{1}{N}) \neq v_2$, Δ is ever decreasing with in q, with $\Delta(0) = v_1^1 - \frac{1}{N} > 0$ and $\Delta(1) = \frac{1}{N} - v_2^1 < 0$. As a result $\Delta(q^*) = 0$ represents the one of a kind symmetric equilibrium $q^* \in (0,1)$. What is more, in case $v_1 = (\frac{1}{N}, \frac{1}{N}, \dots, \frac{1}{N}) \neq v_2$ then $q^* = 0$ with $\Delta\left(\frac{1}{2}\right) < 0$. Whereas, in the case of $v_1 \neq \left(\frac{1}{N}, \frac{1}{N}, \dots, \frac{1}{N}\right) = v_2$, $q^* = 1$ and $\Delta\left(\frac{1}{2}\right) > 0$. The outcome maintains for as long as s is sufficiently small.

Proof expected result 2

The limit is $s \to \infty$. Similar to result 1, participants enter with the same probability each contest $q = \frac{1}{2}$. Hence, $\Delta\left(\frac{1}{2}\right) = \frac{1}{2^{N-1}}(P^\infty(v_1) - P^\infty(v_2))$ when $v_1 \neq \left(\frac{1}{N}, \frac{1}{N}, \dots, \frac{1}{N}\right)$, Δ is ever decreasing with in q, with $\Delta(0) = v_1^1 - v_N^1 > 0$ and $\Delta(1) = v_1^N - v_2^1 < 0$. As a result $\Delta(q^*) = 0$ represents the one of a kind symmetric equilibrium $q^* \in (0,1)$. What is more, $q^* > (<) \frac{1}{2}$ if and only if $\Delta\left(\frac{1}{2}\right) > (<) 0$. The outcome maintains for as long as s is sufficiently large.

Proof expected result 3

As a result of the equilibrium in formula 16, given the prerequisites, the following proof can be given:

(24) $$E[U_n^1] = (1-q)^{N-1}v_1^1 + \sum_{m=2}^{N}\binom{N-1}{m-1}q^{m-1}(1-q)^{N-m}\frac{1}{m}\left(1 - s\left(\frac{m-1}{m} - \frac{1-v_1^1}{m-1}\right)\right)$$

(25) $$E[U_n^2] = q^{N-1}v_2^1 + \sum_{m=2}^{N}\binom{N-1}{m-1}(1-q)^{m-1}q^{N-m}\frac{1}{m}\left(1 - s\left(\frac{m-1}{m} - \frac{1-v_2^1}{m-1}\right)\right)$$

Hence, $\Delta(1) = E[U_n^1] - E[U_n^2]$ is ever decreasing with in q, with $\Delta(0) = v_1^1 - E[U_n^2|N] > 0$

and $\Delta(1) = E[U_n^1|N] - v_2^1 = \frac{1}{N}\left(1 - s\left(\frac{N-1}{N} - \frac{1-v_1^1}{N-1}\right)\right) - v_2^1 < \frac{1}{N}\left(1 - s\left(\frac{N-1}{N} - \frac{1}{2(N-1)}\right)\right) - v_2^1 < \frac{1}{N} - v_2^1 < 0$. As a consequence, $\Delta(q^*) = 0$ represents the one of a kind symmetric equilibrium $q^* \in (0,1)$. What is more, $\Delta\left(\frac{1}{2}\right) = 0$ for as long as, $s = \bar{s}$ with $\bar{s}$ defined as in formula 17. In addition, consider the following:

(26) $$\frac{\partial\Delta}{\partial s}\Big|_{q=\frac{1}{2}} = \frac{v_2^1 - v_1^1}{2^{N-1}}\sum_{m=1}^{N-1}\frac{\binom{N-1}{m}}{m(m+1)} < 0$$

As a result of the fact that within q and s payoffs are continuous, therefore, $q^* > (<)\frac{1}{2}$ if and only if $s > (<)\bar{s}$. In short, $\bar{s}$ is ever decreasing in N.

Proof expected result 4

The first situation can be explained as follows. $P^0(v)$ is maximized with $v^* = (1,0,\dots,0)$, this is a one of a kind and therefore dominated strategy. For that reason $v_1 = v_2 = v^*$ holds.

The second situation can be explained as follows. The potential participants N can be an odd or even number. For both cases the same principle holds, apart from the previously mentioned different N^* formulas. Let's use the binomial coefficient for when N is odd. This is $\binom{N-1}{m-1}$, m is maximized when $m = N^*$. Take into account however, that the binomial coefficient becomes larger when $m < N^* = \frac{N+1}{2}$ for m. The opposite holds when $m > N^*$. Consequently, the one of a kind prize structure $P^{\infty}(v)$ is maximized through $v^* = \left(\frac{1}{N^*}, \frac{1}{N^*}, \dots, \frac{1}{N^*}, 0, \dots, 0\right)$, this is a one of a kind and therefore dominated strategy. For that reason $v_1 = v_2 = v^*$ holds.

The third situation can be explained as follows. The purpose of this case is to provide proof. For the possibility that there is a set limit amount of prizes that can be awarded. Though the sketched situation only deals with a maximum of three, a higher limit works just the same. Assume $v_i = (v_i^1, v_i^2, v_i^3, 0, \dots, 0)$ is the prize structure contest i picks. If $N_i = 1$ then $E\left[U_n^i \middle| N_i\right] = v_i^1$. When $N_i = 2$ and $s \leq 2$ then $e^* = \frac{s}{4}(v_i^1 - v_i^2)$ and $E\left[U_n^i \middle| N_i\right] = \left(\frac{1}{2} - \frac{s}{4}\right) v_i^1 + \left(\frac{1}{2} + \frac{s}{4}\right) v_i^2$. Now, in the case $N_i \geq 3$ it becomes a bit more complicated. The way to approach this is by searching for the probability that the third and last prize in the set limit is obtained by a participant. Suppose the following predispositions, agent l wins first prize, agent m wins second prize and agent $n \in Y_i$ wins v_i^3 third and last prize. The chance for this is:

(27) $$P_{n|lm}^3 = \frac{(e_n)^s}{\sum k \in Y_i - \{lm\} (e_k)^s}$$

As a result, agent n has the following chance of winning third prize:

(28) $$P_n^3 = \sum_{l,m \in Y_i - \{n\}, l \neq m} P_l^1 P_m^2 | l P_m^3 | lm$$

With $P_l^1 = \frac{(e_n)^s}{\sum_{k \epsilon Y_i} (e_k)^s}$ and $P_{m|l}^2 = \frac{(e_n)^s}{\sum_{k \epsilon Y_i - \{m\}} (e_k)^s}$. Additionally, every agent $n \in Y_i$ picks e_n effort, which solves:

(29) $$\max_{e_n > 0} [P_n^1(e_n, e_{-n}) v_i^1 + P_n^2(e_n, e_{-n}) v_i^2 + P_n^3(e_n, e_{-n}) v_i^3 - e_n]$$

The one of a kind pure strategy equilibrium is found by substituting $e_n = e^*$ for all agents $n \in Y_i$, in order to find the first order condition.

(30) $$e^* = \frac{s}{N_i}\left[\frac{N_i - 1}{N_i} v_i^1 + \left(\frac{N_i - 1}{N_i} - \frac{1}{N_i - 1}\right) v_i^2 + \left(\frac{N_i - 3}{N_i - 2} - \frac{1}{N_i - 1} - \frac{1}{N_i}\right) v_i^3\right]$$

Is the effort that is found. The expected payoff every agent $n \in Y_i$ beliefs to receive is:

(31) $$E\left[U_n^i \middle| N_i\right] = \frac{1}{N_i} - e^*$$

This is again a one of a kind equilibrium. If $s \leq \frac{N_i-1}{N_i}$ then the equilibrium for every v_i is present after all, $\frac{N_i-1}{N_i} > \frac{N_i-1}{N_i} - \frac{1}{N_i-1} > \frac{N_i-3}{N_i-2} - \frac{1}{N_i-1} - \frac{1}{N_i}$ holds. Contests know this and maximize $v^1, v^2 \text{ and } v^3$ acordingly within:

(32) $$P^s(v^1, v^2, v^3) = \alpha(s)v^1 + \beta(s)v^2 + \gamma(s)v^3$$

With:

(33) $$\alpha(s) = 1 + (N-1)\left(\frac{1}{2} - \frac{s}{4}\right) - s\sum_{m=2}^{N-1}\binom{N-1}{m}\frac{m}{(m+1)^2}$$

(34) $$\beta(s) = (N-1)\left(\frac{1}{2} + \frac{s}{4}\right) - s\sum_{m=2}^{N-1}\binom{N-1}{m}\left(\frac{m}{(m+1)^2} - \frac{1}{m(m+1)}\right)$$

(35) $$\gamma(s) = -s\sum_{m=2}^{N-1}\binom{N-1}{m}\frac{1}{m+1}\left(\frac{m-2}{m-1} - \frac{1}{m} - \frac{1}{m+1}\right)$$

Disclaimer; $\beta(s) > \alpha(s)$ merely in the case where $s > \bar{s}$ if $\bar{s} \equiv \left(\sum_{m=1}^{N-1}\frac{\binom{N-1}{m}}{m(m+1)}\right)^{-1} \in (0,1)$. Furthermore, $\gamma(s) > \beta(s)$ only when $N \geq 4$ and $s > \bar{\bar{s}}$ if $\bar{\bar{s}} = \frac{N-1}{2}\left(\sum_{m=2}^{N-1}\frac{\binom{N-1}{m}}{(m-1)(m+1)} - \frac{N-1}{4}\right)^{-1} > \bar{s}$. In case $N \geq 6$ it remains that $\bar{\bar{s}} < 1$. Since P^s, which is linear, results into the following prize structure equilibriums $(1,0,\ldots,0)$ for $s \in (0,\bar{s})$, $(\frac{1}{2},\frac{1}{2},0,\ldots 0)$ for $s \in (\bar{s},\bar{\bar{s}})$ and $(\frac{1}{3},\frac{1}{3},\frac{1}{3},0,\ldots 0)$ for $s \in (\bar{\bar{s}},\frac{N}{N-1})$.

The fourth and final situation is rather straightforward. Because $\bar{s}$ only decreases in N with $\lim_{N\to\infty}\bar{s} = 0$ for any $s > 0$. A $\bar{N}$ can occur where $s > \bar{s}$ for every $N \geq \bar{N}$. Following what has been shown in the third situation, a multiple prize structure will be the dominated strategy for the contest. To sum up, when $N \geq \bar{N}$ then an optimal contest strategy is to have two or more prizes.

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Results

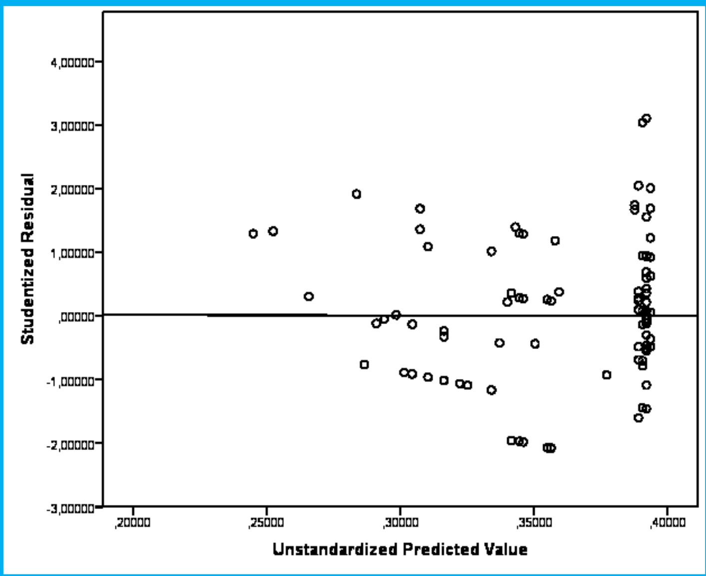
Descriptive Statistics
Weekend Tournament

	N	Minimum	Maximum	Mean	Std. Deviation
Measure of steepness 1:total	76	0.20440252	0.75	0.40	0.107
Total prize pool	76	$4000.-	$250,000.-	$47,322.-	$47,691.-
Number of available seats	76	10.00	128.00	39.03	29.76
Number of prizes	75	3.00	32.00	13.45	7.57
Duration in days	75	2	6	3.29	0.983
Average match duration	71	10:01	23:01	17:17	03:28
Top four participants	70	6.00	98.50	45.04	22.42

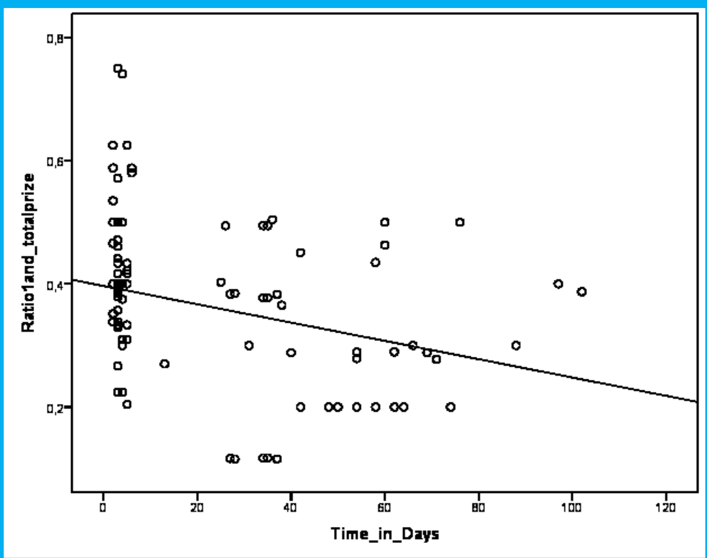
Descriptive Statistics
Grand Tournament

	N	Minimum	Maximum	Mean	Std. Deviation
Measure of steepness 1:total	47	0.11565217	0.625	0.32	0.130
Total prize pool	44	$1930.-	$188,120.-	$91,437.-	$53,899.-
Number of available seats	44	16.00	64.00	35.09	10.85
Number of prizes	44	4.00	64.00	30.00	13.09
Duration in days	43	25	102	49.81	19.816
Average match duration	44	11:12	23:08	18:59	03:12
Top four participants	40	5.00	81.00	20.07	16.89

Residual Plot one



Scatterplot



Model Summary				
	R	R Square	Adjusted R Square	Std. Error
Model 1 Scatterplot	0.310	0.096	0.088	0.116

Panel A		Measure of prize structure steepness							
Dep Var		C.I.	1:2	1:3	1:total	C.I.	1:2	1:3	1:total
Time in days	Coefficient	0.000	0.000	0.000	-0.001	0.000	0.001	0.001	-0.002
	Std. Error	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.000
	Sig.	0.519	0.819	0.352	0.001	0.336	0.099	0.117	0.000
Constant	Coefficient	0.366	0.503	0.275	0.397	0.342	0.544	0.332	0.394
	Std. Error	0.008	0.012	0.013	0.014	0.010	0.014	0.014	0.017
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total prize	Coefficient					0.000	0.000	0.000	0.000
	Std. Error					0.000	0.000	0.000	0.000
	Sig.					0.000	0.000	0.000	0.829
Observations		119	119	119	119	119	119	119	119

Panel B		Measure of prize structure steepness							
Dep Var		C.I.	1:2	1:3	1:total	C.I.	1:2	1:3	1:total
Grand Tournament	Coefficient	0.018	-0.012	-0.024	-0.090	-0.002	0.024	0.025	-0.094
	Std. Error	0.013	0.020	0.021	0.022	0.014	0.020	0.020	0.024
	Sig.	0.173	0.551	0.254	0.000	0.898	0.228	0.200	0.000
Constant	Coefficient	0.363	0.506	0.276	0.399	0.340	0.546	0.334	0.395
	Std. Error	0.008	0.012	0.013	0.013	0.010	0.014	0.014	0.017
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total prize	Coefficient					0.000	0.000	0.000	0.000
	Std. Error					0.000	0.000	0.000	0.000
	Sig.					0.000	0.000	0.000	0.660
Observations		119	119	119	119	119	119	119	119

Panel C		Measure of Steepness			
Dep Var		C.I.	1:2	1:3	1:total
2012-2013	Coefficient	-0.026	0.031	-0.005	-0.045
	Std. Error	0.013	0.019	0.021	0.022
	Sig.	0.049	0.110	0.801	0.046
Constant	Coefficient	0.384	0.484	0.270	0.391
	Std. Error	0.010	0.014	0.016	0.017
	Sig.	0.000	0.000	0.000	0.000
Observations		119	119	119	119

Panel C*	Number of tournaments	
	2010-2013	2012-2013
Grand Tournaments	41	22
Weekend Tournaments	75	46
Ratio	0.55	0.46

Panel C**		Measure of Steepness
Dep Var		1:total prize pool
2012-2013 Grand T.	Coefficient	-0.105
	Std. Error	0.030
	Sig.	0.001
2012-2013 Weekend T.	Coefficient	-0.016
	Std. Error	0.024
	Sig.	0.499
Constant	Coefficient	0.392
	Std. Error	0.016
	Sig.	0.000
Observations		119

Panel D		Participation Measure	
Dep Var		Grand Tournaments	Weekend Tournaments
1: total	Coefficient	47.731	20.971
	Std. Error	23.095	24.654
	Sig.	0.046	0.398
Total prize	Coefficient	0.000	0.000
	Std. Error	0.000	0.000
	Sig.	0.049	0.090
Constant	Coefficient	15.871	41.503
	Std. Error	7.706	11.025
	Sig.	0.047	0.000
Observations		41	75

Panel E		Average match duration	
		(1)	(2)
Ratio 1: Total	Coefficient	391.830	
	Std. Error	154.057	
	Sig.	0.012	
Total prize	Coefficient	0.001	
	Std. Error	0.000	
	Sig.	0.058	
Weekend Tournament	Coefficient	994.187	
	Std. Error	195.291	
	Sig.	0.000	
Grand Tournament	Coefficient	-208.731	
	Std. Error	227.362	
	Sig.	0.363	
Total prize Weekend T.	Coefficient		0.001
	Std. Error		0.001
	Sig.		0.032
Total prize Grand T.	Coefficient		0.000
	Std. Error		0.001
	Sig.		0.846
1: total * Weekend T.	Coefficient		1051.393
	Std. Error		194.844
	Sig.		0.000
1:total * Grand T.	Coefficient		-411.279
	Std. Error		245.423
	Sig.		0.102
Observations		119	119